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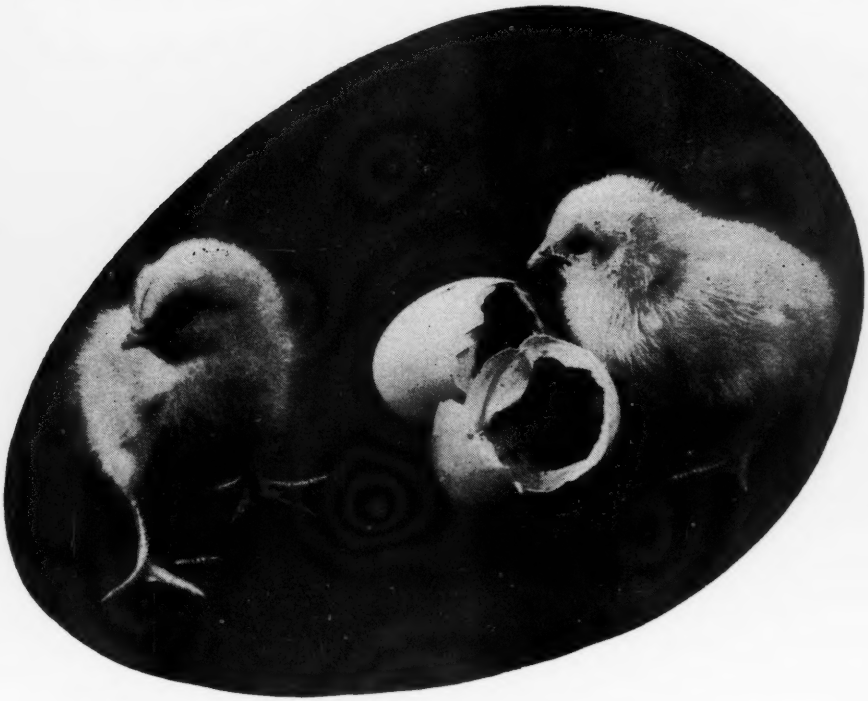
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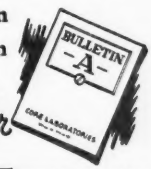
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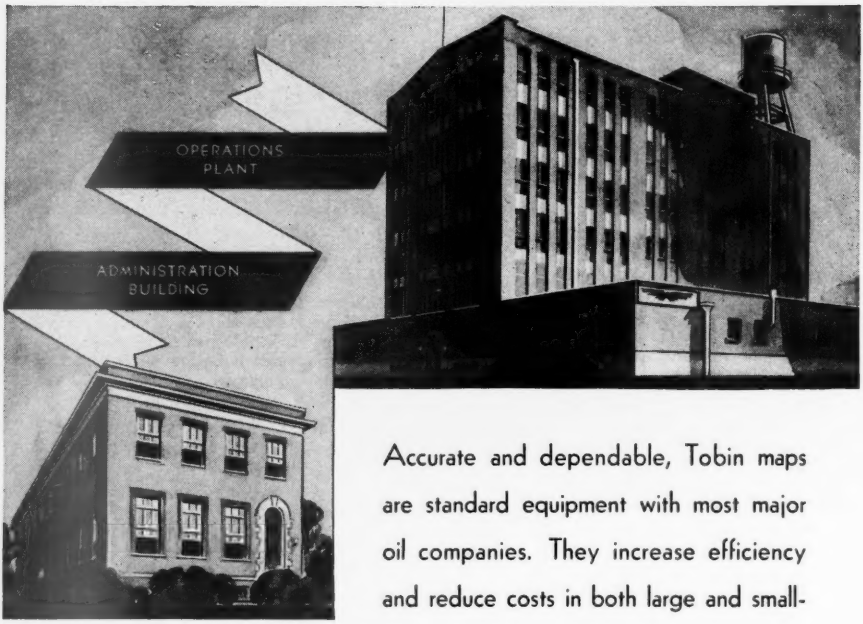
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Foreword

By RONALD K. DEFORD and E. RUSSELL LLOYD

Permian of West Texas and Southeastern New Mexico

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AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

MARCH, 1942

STRATIGRAPHY AND INSOLUBLE RESIDUES OF MADISON GROUP (MISSISSIPPIAN) OF MONTANA[1]

LAURENCE L. SLOSS[2] AND RALPH H. HAMBLIN[2]
Butte, Montana

ABSTRACT

The widespread Lower Mississippian limestones of the Madison group were deposited in a basin extending eastward from the Cordilleran trough, bounded on the north in Alberta and Saskatchewan by a positive element related to the Sweetgrass arch, and on the south by positive elements of northern Colorado and northwestern Nebraska. The limestones may be divided into two persistent formations: the very massive Mission Canyon limestone overlying the well bedded Lodgepole limestone. The Lodgepole is divisible into an upper member, the Woodhurst, largely limestone with thin shale partings, and a lower member, the Paine, with a much larger percentage of shale. Petroleum-reservoir zones, largely confined to the Mission Canyon, appear to have been controlled by five factors: solution, dolomitization, sandy zones, reworking of oölitic and granular material, and fracturing. Insoluble-residue analysis indicates that the formations and members of the group may be recognized by that means in a large area and that zones within formations may be determined in limited areas.

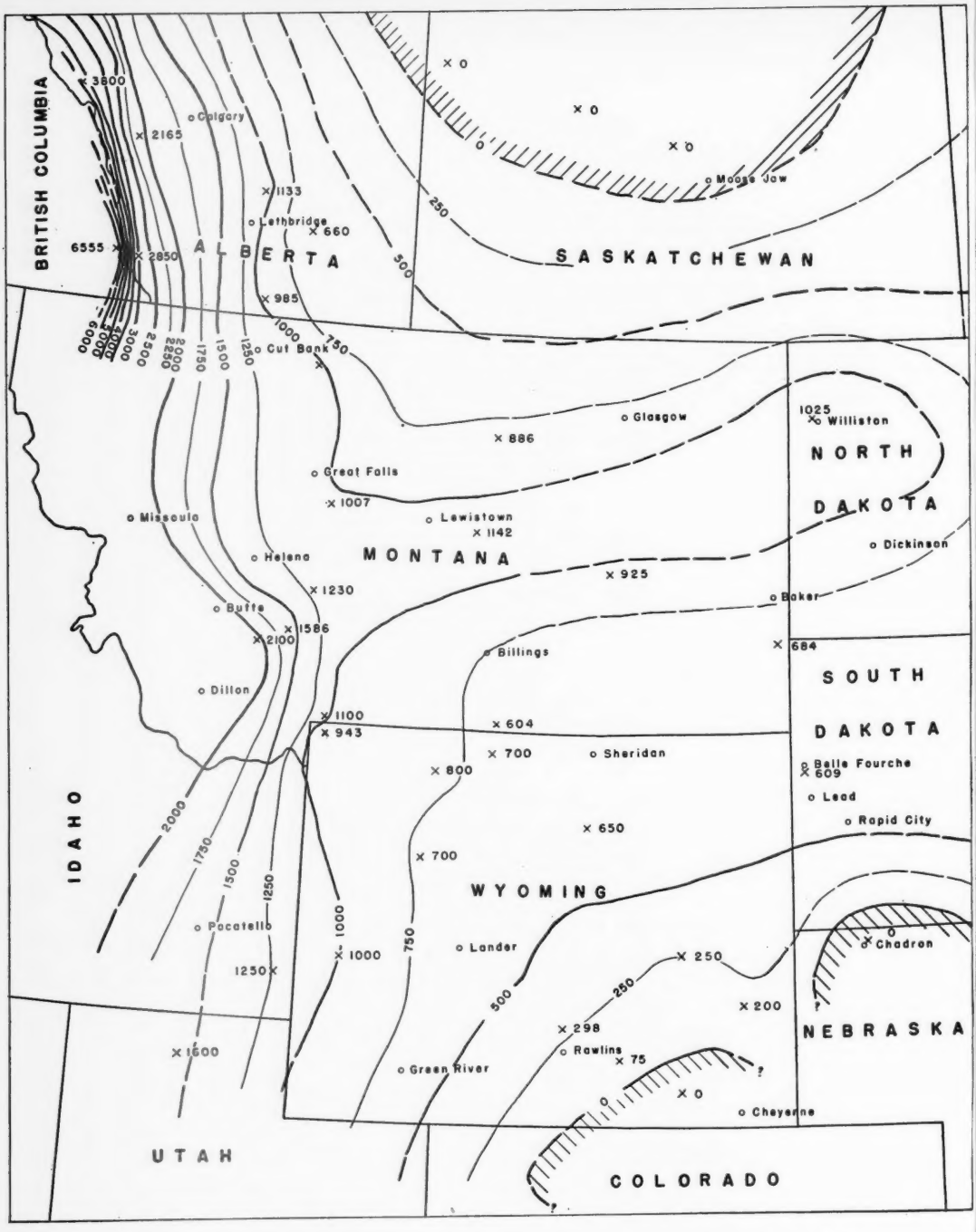
DEFINITION

The Lower Mississippian limestones of the Madison group have been known and studied for many years in the northern Rocky Mountains and uplifts of the northwest Great Plains where the outcrops of these massive limestones add much to the rugged physiography of the mountainous areas. The limestones, however, have received but little detailed attention and only at widely separated points. It is the purpose of this paper to discuss the distribution, economic importance, stratigraphic relations, petroleum-reservoir zones, and means of identification of the Madison group.

Although the Madison limestones are richly fossiliferous in certain areas or at certain horizons, experience in the field has proved that the occurrence of fossils can not be relied on to identify units of the group. There are entirely too many localities which yield no fossils or where

[1] Manuscript received August 11, 1941. Published with the permission of the director of the Montana Bureau of Mines and Geology.

[2] Montana School of Mines.



ISOPACH MAP OF THE MADISON GROUP

FIG. 1.—Thickness of Madison group subsequent to late Paleozoic and early Mesozoic erosion.

the fossils are so tightly bound in the matrix as to make recognition impossible. A few Ostracoda and Foraminifera are known, but the microfauna is too meager to be of value in the identification of well cuttings. Therefore, in order to make possible the identification of both surface and subsurface samples, the writers have employed insoluble residues with some success. Work now in progress indicates that zoning may be possible on the basis of the rich, rugose coral fauna—types that may be identified in fragmental or massive material. The results of the latter investigation, however, are not sufficiently advanced to include with this paper.

The field and laboratory investigation involved in this paper has been accomplished through the support of the Montana Bureau of Mines and Geology as part of its program for aiding in the development of the mineral resources of the state. Many valuable data contained in this report were contributed by O. A. Seager, G. R. Downs, and D. L. Blackstone, Jr., of the Carter Oil Company. A special debt of gratitude is due E. S. Perry of Montana School of Mines for his unfailing interest and valuable aid in the prosecution of the field and laboratory research.

ECONOMIC SIGNIFICANCE

Although the limestones of the Madison group are important locally as a source of cement rock and as agricultural and industrial lime, the chief economic interest in the group lies in its potentialities as a reservoir rock for petroleum and natural gas. In northern Montana and southern Alberta important quantities of oil and gas have been and are being produced from the Madison in the Kevin-Sunburst, Pondera, Turner Valley, and other fields. In the Baker-Glendive field of eastern Montana, oil in commercial quantities occurs in what is believed by some to be Madison limestone, and a wildcat well north of the Cut Bank field encountered gas spraying oil in the Madison. Southward in northern Wyoming, Madison oil is produced in the Garland and Frannie fields, while showings of oil have been found in the Madison in the Salt Creek and Torchlight fields.

Elsewhere in Montana, Alberta, the Dakotas, and Wyoming, the Madison has been tested and showings of oil have been reported locally. Ordinarily, wildcat wells drilled into the Madison away from proved fields have yielded large volumes of water. In the Little Belt Mountains and Little Rocky Mountains, many solution cavities in outcrops of Madison limestone contain bituminous material. Almost universally samples from the lower two-thirds of the Madison yield

heavy films of oil during acid digestion in the process of recovering insoluble residues.

In view of the petroliferous character of the beds and the widespread distribution of commercial production from the Madison in an area 600 miles long and 300 miles wide, it is natural to speculate about the possibility of other localities not discovered, or zones not tested, where important amounts of Madison oil might occur. Experience has indicated that localization of zones of high porosity and permeability, rather than anticlinal structure, is the controlling factor in the accumulation of Madison oil in Montana. This is graphically demonstrated in the Kevin-Sunburst field where many of the highly productive areas within the field behave independently as isolated units but little influenced by structure. This does not mean that prospecting should proceed without regard to structure, for, given areas of widespread and continuous porosity and permeability, structure may well become the controlling factor as it appears to be in the Turner Valley field. It also follows, however, that commercial accumulations of Madison oil may be discovered in areas lacking dominant structural features. It is in such areas that the geologist must rely on studies of paleogeography, conditions of sedimentation, and the modes of development of porosity and permeability. It is hoped that this paper will be a step toward the solution of some of these problems.

DISTRIBUTION

The limestones to which the term Madison is applied are part of an enormously widespread series of Lower Mississippian sediments deposited in the Cordilleran geosyncline and adjoining western part of the continental interior. There is little doubt that these sediments join on the east with Kinderhook and Osage sediments of the Mississippi Valley.

Where the Paleozoic section is exposed or penetrated in Montana, the Madison group is found. It is assumed that the rocks are present beneath the thrust sheets of northwestern Montana, but complete sections are rarely available in the overthrust masses. At the north in Canada, the distribution is limited on the Sweetgrass arch by pre-Jurassic and pre-Cretaceous erosion which removed Mississippian rocks from northern Alberta and most of northern Saskatchewan. At the southwest, all Paleozoic records are lost beneath the lavas of the Snake River Plateau. On the east, information is lacking beyond the Black Hills and the deep wells of western Nebraska, North Dakota, and South Dakota. At the southeast, on the boundary between Wy-

oming and Colorado, as indicated by exposures in the Laramie Mountains[3] and Medicine Bow Mountains,[4] and in northwestern Nebraska, as indicated by two deep wells (Nebraska Oil Company's Duffy No. 1 and Ohio Oil Company's Demmer No. 1[5]), the Mississippian is lacking through erosion or non-deposition on positive areas related to the Uinta-Front Range element.

The area covered by the writers' investigation lies between Idaho and North Dakota and between Colorado and central Alberta. The limits of this area are characterized on the east and west by deep burial of Lower Mississippian strata, on the north by erosion, on the southeast by erosion and non-deposition, and on the southwest by lack of information.

STRATIGRAPHIC RELATIONS

Throughout southern Alberta, most of Montana, and western Wyoming, the Madison limestones lie conformably on the Upper Devonian Three Forks formation (Minnewanka of Alberta). From the Pryor and Big Horn uplifts of southern Montana and northern Wyoming to the Black Hills, the Madison disconformably overlies Ordovician. As southeastern Wyoming is approached the Lower Mississippian rests successively on older and older horizons until in the Medicine Bow Mountains and Laramie Mountains it lies with pronounced unconformity on pre-Cambrian basement rocks.

Where the contact of the Madison group with overlying formations is well exposed, evidence of an erosion interval is found. The amount of time involved in the interval was, however, extremely variable. Above the Madison, in central and northern Wyoming, Branson[6] has recognized sediments of Salem to Sainte Genevieve age in beds which were included in the Amsden formation. In southern Montana, from the Tobacco Root Mountains to the Big Horn Mountains and probably in the Black Hills, the Madison is topped by red sandstones, shales, and limestones, of the Amsden formation. The basal Chester sandstones contain fragments of Madison limestone, and Amsden sandstone fills solution channels developed in the Madison. In the Big

[3] G. E. Condra, E. C. Reed, and O. J. Scherer, "Correlation of Formations of the Laramie Range, Hartville Uplift, Black Hills and Western Nebraska," *Nebraska Geol. Survey Bull. 13* (1941), pp. 8, 10, 11.

[4] Joseph Neely, "Geology of the North End of the Medicine Bow Mountains, Carbon County, Wyoming," *Wyoming Geol. Survey Bull. 25* (1934), p. 4.

[5] O. A. Seager, personal communication (1941).

[6] C. C. Branson, "Stratigraphy and Fauna of the Sacajawea Formation, Mississippian, of Wyoming," *Jour. Paleontology*, Vol. 11, No. 8 (December, 1937), pp. 650–60.

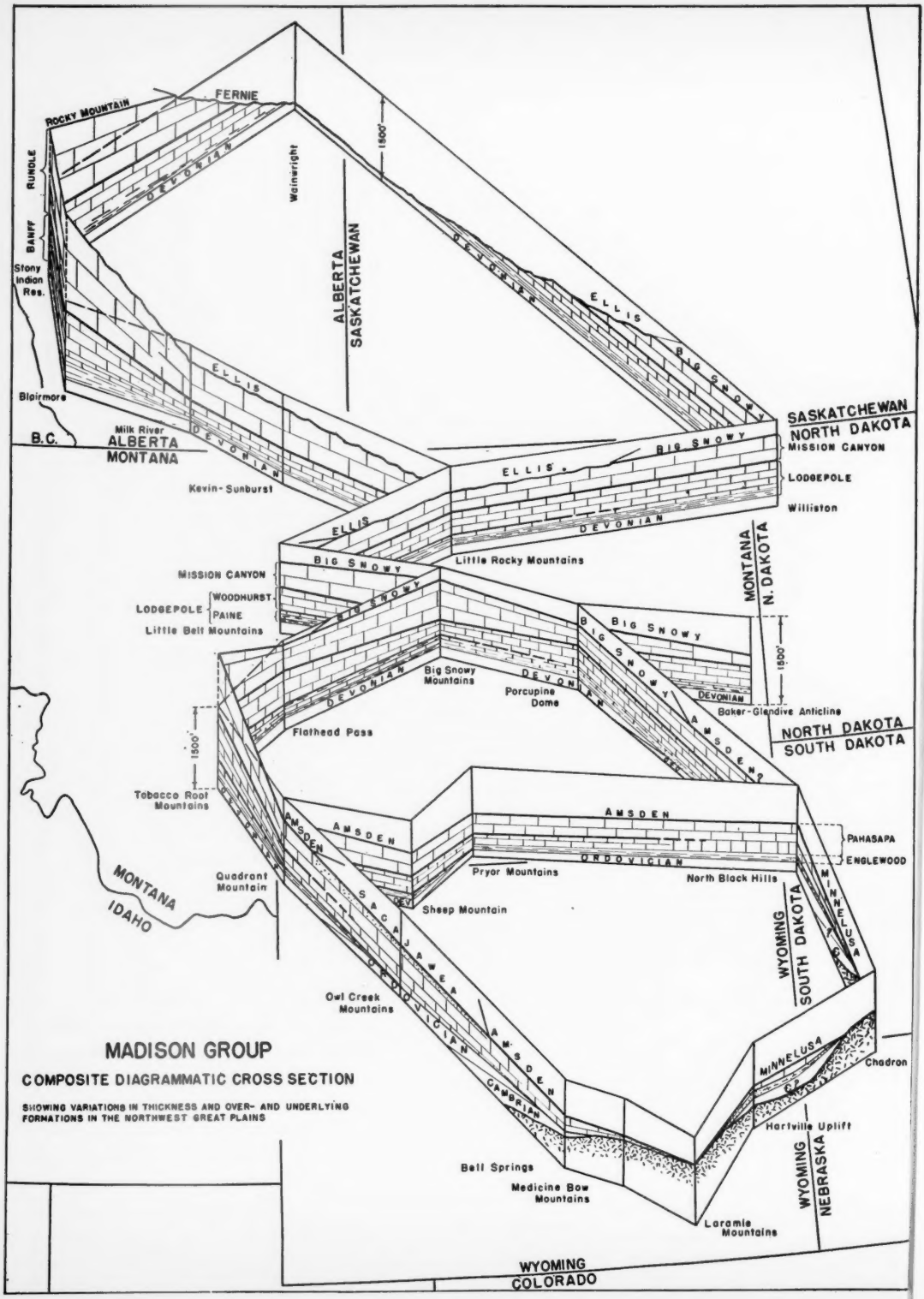


FIG. 2.—Madison group. Composite diagrammatic cross section.

Horn Mountains an appreciable angularity is recognized between the Madison and Amsden.[7]

In the Little Belt Mountains and Big Snowy Mountains of central Montana and, as indicated by deep wells, in the Porcupine dome and Baker-Glendive field of eastern Montana, and the Williston basin of northwestern North Dakota the Madison is overlain by the Big Snowy group, ranging in age from middle Valmeyer to middle Chester, according to a preliminary report by Scott.[8]

North of Little Belt Mountains and Big Snowy Mountains, pre-Jurassic erosion has stripped the younger Paleozoics from above the Madison, and it is overlain in the Little Rocky, and Sweetgrass uplifts by the Jurassic Ellis formation. This condition prevails throughout northern Montana and south-central Alberta as indicated by extensive drilling. Until faunal zones are established for the upper members of the Madison, it will be difficult to estimate the depth to which pre-Jurassic erosion of the Madison penetrated, but the thicknesses measured in northern Montana and southern Alberta indicate that the depth of erosion was slight in those areas. That the Mesozoic erosion was limited on the west is indicated by the presence of the Pennsylvanian Rocky Mountain quartzite and Upper Mississippian limestones above the Madison at Crow's-Nest Pass in southern Alberta and at Banff and Jasper parks.

GEOLOGIC AGE

The fauna of the Madison group has not been studied in detail but preliminary work has indicated a Kinderhook and Osage age for the limestones. Blackstone's[9] work on the brachiopod fauna shows that a great majority of the species may be assigned to the early Mississippian with a few anomalous occurrences of types common to the late Mississippian of the Mississippi Valley. The writers have not encountered Meramec or Chester elements in their work on the Madison in Montana, but recognize that it is possible for limestones of late Mississippian age to rest with apparent conformity on the Madison, making separation on lithologic grounds difficult. Such a situation might arise if Brazer equivalents like the Yakinikak limestone were found above the Madison.

The base of the Madison may be dated rather accurately by the

[7] W. T. Thom, "Oil and Gas Possibilities in and near the Crow Indian Reservation, Montana," *U. S. Geol. Survey Bull. 736*, Pt. II (1922), p. 41.

[8] H. W. Scott, "Some Carboniferous Stratigraphy in Montana and Northwestern Wyoming," *Jour. Geology*, Vol. 43 (1935), p. 1031.

[9] D. L. Blackstone, Jr., "Mississippian Brachiopods of Montana," *unpublished Master's Thesis* (Montana State University, 1934).



FIG. 3.—Madison group near Gallatin Gateway, southwestern Montana. 1. Mission Canyon. 2. Lodgepole. 3. Woodhurst member. 4. Paine member.

conodont fauna of the basal shale. Knechtel and Hass[10] describe a fauna "most like the Kinderhook assemblages from the Bushberg sandstone member of the Sulphur Springs formation and from the Hannibal shale of northeastern Missouri." Conodonts from the basal shale in the Big Snowy Mountains were examined by Cooper[11] whose preliminary work indicates a correlation with the Woodford, New Albany, and other Chattanooga equivalents.

DIVISIONS

The first detailed investigation of the Madison limestones resulted from Peale's work on the Three Forks Quadrangle. Peale[12] first applied the term, "Madison," to the rocks in question, but it is apparent that he did not imply that the type section was on Madison River or in the Madison range. The term was evidently derived, along with the terms Gallatin and Jefferson, from the rivers which form the Missouri near Three Forks. These terms were apparently arbitrarily applied to units of the Paleozoic section and none, with the possible exception of the now obsolete Gallatin formation, carries any significance as far as type sections are concerned.

The term Madison is preoccupied in the literature by an Upper Cambrian sandstone,[13] but the Committee on Geologic Names of the United States Geological Survey considers that the geographic and stratigraphic separation is sufficient to permit the retention of the familiar term Madison for Lower Mississippian rocks in Montana and Wyoming.

What may be considered the type section is exposed along Gallatin River at Logan. Peale in describing this section recognized a three-fold division of Madison strata into "laminated limestones" at the base, "massive limestones" in the central part, and "jaspery limestones" at the top. Weed[14] defined a roughly correlative division into Paine shale, for Peale's "laminated beds," Woodhurst limestone for the middle part, and Castle limestone for the upper part. Weed applied the term Madison group to the limestones, but it is not thought that he in-

[10] M. M. Knechtel and W. H. Hass, "Kinderhook Conodonts from Little Rocky Mountains, Northern Montana," *Jour. Paleontology*, Vol. 12 (1938), p. 518.

[11] Chalmer L. Cooper, personal communication.

[12] A. C. Peale, "The Paleozoic Section in the Vicinity of Three Forks, Montana," *U. S. Geol. Survey Bull. 110* (1893).

[13] R. D. Irving, "Note on Some New Points in the Elementary Stratification of the Primordial and Canadian Rocks of South Central Wisconsin," *Amer. Jour. Sci.*, 3d Ser., Vol. 9 (1875), p. 442.

[14] W. H. Weed, "Geology of the Little Belt Mountains, Montana," *U. S. Geol. Survey 20th Ann. Rept.*, Pt. III (1899), pp. 289–94.
———, "Fort Benton, Montana," *U. S. Geol. Survey Geol. Atlas Folio 55* (1899).

tended a formational rank for his three units. From his treatment of the so-called Quadrant as a group in the Little Belt paper[15] and as a formation in the Fort Benton Folio it is clear that Weed's[16] concept of a group is not the present one. Therefore, Weed's divisions of the Madison are considered as members by the United States Geological Survey and the writers.



FIG. 4.—Madison group on Belt Creek, near Monarch, Little Belt Mountains. 1. Mission Canyon limestone. 2. Lodgepole limestone. 3. Woodhurst member. 4. Paine member.

The first discussion of Madison rocks as comprising a true group was by Collier and Cathcart[17] who divided it into a lower unit which they called the Lodgepole limestone and an upper unit called Mission Canyon limestone, both named for canyons on the north flank of the Little Rocky Mountains. The strata called Mission Canyon by Collier and Cathcart are lithologically and faunally identical with Weed's

[15] W. H. Weed, *op. cit.*, p. 294.

[16] W. H. Weed, "Fort Benton, Montana," *U. S. Geol. Survey Geol. Atlas Folio 55* (1899).

[17] A. J. Collier and S. H. Cathcart, "Possibility of Finding Oil in Laccolithic Domes South of the Little Rocky Mountains, Montana," *U. S. Geol. Survey Bull. 736*, Pt. II (1922), p. 173.

Castle limestone, but as the latter term has been discarded, it is proposed that the terms Mission Canyon and Lodgepole be applied throughout Montana and northern Wyoming. Field work has indicated that such usage is practicable and that the formations are easily mappable cartographic units wherever encountered. In the early work on this problem it was thought that Weed's lower units, Paine and

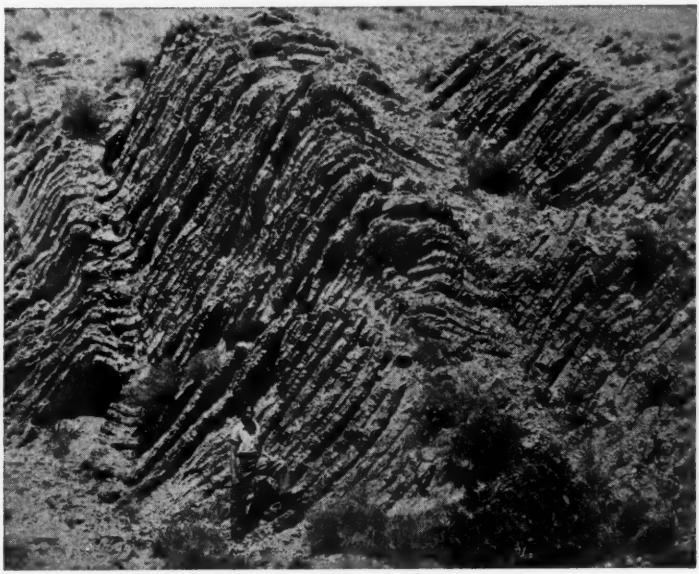


FIG. 5.—Paine member of Lodgepole limestone near Armstead, southwestern Montana. Thin-bedded limestone intercalated with calcareous shales.

Woodhurst, could be used as formations throughout the area, but this did not prove to be the fact, and it is proposed that they be treated as members of the Lodgepole.

LITHOLOGY

In a number of localities where the base of the Lodgepole is well exposed, it is marked by a series of black fissile shales with a conodont fauna correlative with the Chattanooga and Woodford shales of the Mississippi Valley and Mid-Continent areas. This fauna will be discussed in more detail elsewhere, but it is interesting to note the presence of a widespread black shale in the Rocky Mountains and Great Plains at the same stratigraphic position as the Chattanooga type

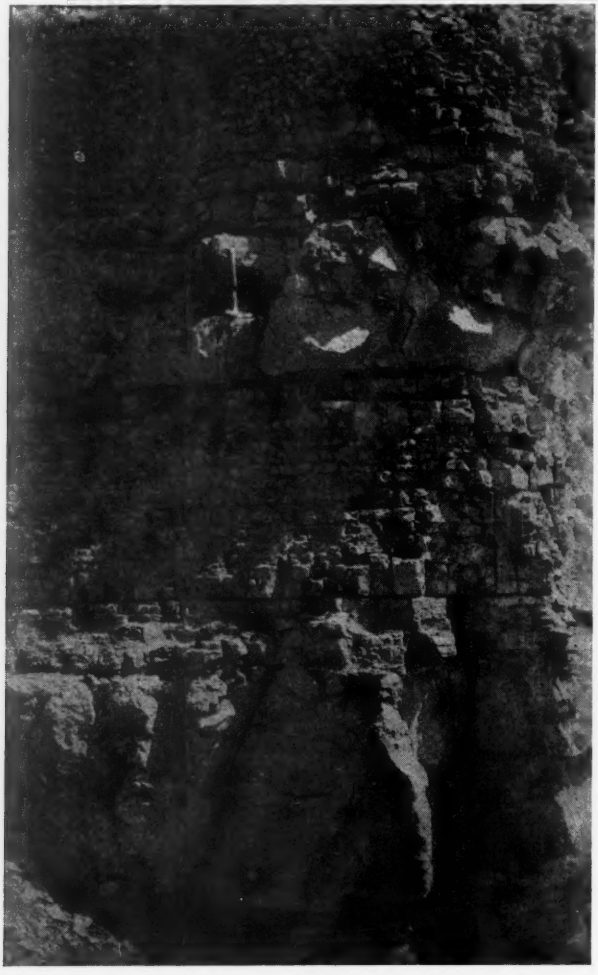


FIG. 6.—Woodhurst member of Lodgepole limestone on Belt Creek, Little Belt Mountains. Alternating massive and thin-bedded limestones with thin shale partings.

shales 800–2,000 miles east. The log of a deep well near Williston, North Dakota,[18] reveals a thickness of about 100 feet for this unit at

[18] The California Company's Kamp No. 1 (Nesson anticline).

that locality. It thins to about 20 feet in central Montana, but its potentialities as a source rock must be considered. A black shale in a similar position but containing an Upper Devonian fauna has been described in Alberta as the Exshaw shale.[19]

Above the basal shale of the type locality in the Little Rockies the Lodgepole consists of a fairly uniform series of well bedded blocky limestones in beds about 3 feet thick separated by 1- to 3-inch partings of calcareous shales. In the lower half of the formation the limestones are dark gray to brown in color and are predominantly fine-grained. The upper half contains many red and maroon-colored limestones and shale partings, the weathering of which imparts a red color as a stain to the whole Lodgepole section. The red coloring matter of the Lodgepole is an essential, original constituent of the partings themselves and bright reds are apparently confined to the Little Rocky Mountain area. At many other localities the Lodgepole outcrops display a characteristic yellow or light orange weathered surface.

The division of the Lodgepole into its members is not clear in the type section, but near the middle of the section two highly massive beds composed of a detritus of crinoidal material are believed to mark the base of the Woodhurst member. Similar zones are found at the base of the Woodhurst in a wide area, and the crinoidal material is found throughout the member characteristically overlying channeled surfaces. The abundance of fragmental crinoid plates, and the channeling, indicate diastematic pauses in deposition during which currents were active.

The Woodhurst is lithologically constant where observed, but the Paine member is exceedingly variable. At its type locality in the Little Belt Mountains and throughout the southwestern part of the state, the Paine is characterized by thin-bedded dense limestones in units averaging 5 inches thick separated by almost equal amounts of calcareous shale and shaly limestone. Chert lenticules are common and, though the crinoidal zones are almost completely lacking, there is a rich bryozoan fauna. In the Big Snowy Mountains the Paine member is highly massive and was obviously deposited under much more stable conditions than those on the south and west. Eastward from the Bridger and Gallatin ranges, the Paine thins progressively and is apparently missing in the Pryor Mountains and Big Horn Mountains where the Madison disconformably overlies Ordovician rocks. The eastward thinning is apparently the result of the diminution of the

[19] P. S. Warren, "Age of the Exshaw Shale in the Canadian Rockies," *Amer. Jour. Sci.*, Vol. 33 (1937), pp. 454–57.

amount of shale present between the limestone beds. Without the shale partings the Paine is a cliff-forming fine-grained limestone, split into laminae by chert lenticules and seams.

The Mission Canyon appears almost invariably as a uniform succession of poorly bedded, highly massive, pure limestones which form impressive cliffs or weather into turreted or castellated shapes. Chert is commonly present in the middle of the unit and may occur in very large masses. The formation is variable in color from cream-white to dark gray or brown with the lighter shades predominating. Where studied, the Mission Canyon has been subjected to intense solution action partly Paleozoic in age, which, in most places, occurred prior to the deposition of the overlying formation. In the area of the Sweetgrass arch, where the Mission Canyon was exposed to extensive pre-Jurassic erosion, a karst topography was apparently developed. In most of the area studied, large filled caverns were observed, the filling being a coarse "solution breccia" formed by the collapse of cavern roofs. These breccias are commonly colored red or maroon by infiltration from the overlying Kibbey or Amsden formations. Near Livingston, red Amsden sandstone forms clastic "sills" and "dikes" in solution channels cut 200 feet into the Mission Canyon. Near Whitehall, the collapsed limestone has been washed and abraded to a cobble-conglomerate which lies in large masses discordant to the bedding planes. The contribution of solution work to reservoir conditions is discussed later in this paper.

At numerous localities, particularly in the Little Rocky Mountains the massive limestones of the Mission Canyon exhibit cross-lamination on a large scale. On close examination such members are seen to be calcite sands whose grains are saccharoidal crystal aggregates, or, more rarely, oölites. According to Hatch, Rastall, and Black,[20] limestone sands may be deposited at a considerable distance from their source, and finer material may be deposited directly as grains from saturated solutions of calcium carbonate. The marked cross-lamination indicates current action, and considering the amount of material involved, it seems more likely that unconsolidated calcite grains resuspended after deposition, rather than grains in process of deposition, were acted upon by the currents.

The following are condensed versions of some of the sections measured by the writers. The numbers of the units correspond with the numbers on the graphic sections (Fig. 8).

[20] F. H. Hatch, R. H. Rastall, and M. Black, *The Petrology of Sedimentary Rocks*, 3d ed., p. 182. George Allen and Unwin, Ltd., London (1938).

MEASURED SECTIONS

Little Belt Mountains

SECTION AT RICEVILLE

Kibbey sandstone. Red sandstone and shale
Mission Canyon limestone

	Thickness in Feet	
1.	105	Massive cliff-forming light buff to chocolate brown fine-grained limestone Top bed light gray and fossiliferous
2.	20	Thin-bedded limestone
3.	30	Massive buff fine-grained limestone
4.	10	Predominantly calcareous shale
5.	10	Massive buff limestone

SECTION AT MONARCH

6.	Covered interval	
7.	50	Cream to buff very massive fine-grained cherty limestone
8.	40	Brown to dark gray massive fine-grained limestone
9.	30	Massive light buff and light gray dense limestones with silicified lenses and large bands of dark red chert
10.	90	Cream, light buff yellow, and light gray coarsely crystalline massive limestone with numerous zones of crinoid and brachiopod fragments
11.	60	Gray and brown massive fine-grained limestones, some weathering to flaggy fragments; one cavernous zone with numerous productids

Lodgepole limestone
Woodhurst member

12.	152	Zone massive near top, grading into Mission Canyon facies. Predominantly light and medium shades of buff and brown limestones in beds averaging 2½ feet, in places 6 feet, separated by fine shaly partings. Most beds fine-grained; here and there coarsely crystalline zones contain high percentage of fossil fragments. Shale partings less conspicuous near top of unit
13.	252	Predominantly dark gray fine-grained limestones in 2-foot beds separated by thin calcareous shale partings. Many red or pink weathering zones of coarse fragmental fossil material. Base of unit marked by two massive ledge-forming beds of dark coarse-grained crinoidal limestone Paine member
14.	170	Dark gray fine-grained limestone in beds averaging 6 inches interbedded with almost equal quantities of calcareous shale. Weathered surfaces display abundant silicified fenestellate and branching bryozoans and crinoid columnals. Elongate chert nodules parallel with bedding planes common. Many strata change laterally from limestone to calcareous shale

SECTION ON DRY FORK OF BELT CREEK

15.	28	Paine member as above
16.	22	Covered interval obscuring Devonian-Mississippian contact

Three Forks limestone. Massive dense brown limestone

Big Snowy Mountains

SECTION AT MOUTH OF SWIMMING WOMAN CANYON

Kibbey sandstone. Red sandstones and shales
Mission Canyon limestone

1.	56	Massive medium-grained predominantly light-colored gray and brown limestones. Here and there zones of dark subrounded chert masses. More finely bedded pink weathering zone at base of this succession of beds
2.	48	Zone of reddish limestone breccia apparently caused by collapse of solution caverns. Walls of cavities light gray to brown massive limestone
3.	30	Finely bedded coarsely crystalline gray limestone with a few shaly partings
4.	129	Massive fine-grained medium brown limestone. Fossiliferous zone in lower part

	Thickness in Feet	
5.	88	Massive ridge-forming gray limestone forming south gate of canyon. Reddish solution breccia at base
6.	221	Interval largely covered. Very massive, easily weathered gray fine-grained limestone with small irregular chert lenticules
7.	118	Massive, predominantly brown, saccharoidal limestone. A few zones of fossil fragments

SECTION ON EAST SIDE OF SWIMMING WOMAN CANYON

Lodgepole limestone

Woodhurst member

8.	74	Massive beds of limestone with fine yellow shaly partings, here and there coarsely crystalline fossiliferous zones; one zone with numerous orthid brachiopods. Few beds of very fine-grained dark gray to black limestone
9.	110	Interbedded black and buff fine-grained black limestones with thin yellow shaly partings. Zone of thinly bedded purple-weathering beds near base of unit. A few finely cross-bedded zones and zones of coarse crinoidal fragments
10.	37	Dark brown to black dense limestone interbedded with lenses of yellow shaly limestone
11.	73	Intensely fossiliferous dark gray coarsely crystalline zones made up of crinoid columnals interbedded with few dark fine-grained limestones. Crinoidal beds rest on uneven eroded surfaces of fine-grained beds. Few shaly beds. Planispiral gastropods at top

Paine member

12.	45	Light buff to pale yellow very dense almost lithographic limestone in massive beds. Small cavities filled with free calcite crystals
13.	52	Ledge-forming massive dark gray to black limestone with minor chert lenticules, some hollow. Coarsely crystalline and fossiliferous at base, dense and with conchoidal fracture at top
14.	25	Gray to black, dense to finely crystalline, purple-weathering limestone. Small chert nodules, cavities filled with calcite crystals. Productids, *Platycrinus* (?), *Spirifer* cf. *centronatus*
15.	35	Brown saccharoidal to coarse massive limestone and dolomite. Profusion of crushed and silicified fossil fragments
16.	20±	Black fissile shale bearing conodonts. (Observed on Great House Peak on north wall of canyon. Not exposed on east wall.)

Three Forks formation. Alternating bands of massive gray or brown limestone and gray, yellow-weathering chert. *Gypidula, Spirifer whitneyi, Phillipsastraea, Favosites*

Little Rocky Mountains

SECTION ON LODGEPOLE CREEK

Ellis formation. Variegated shales

Disconformity

Mission Canyon limestone

1.	180	Extremely light-colored limestones, predominantly cream, in places yellow or gray-green, texture granular. *Platycrinus*, large solitary corals, cerioid compound corals
2.	141	Predominantly white, in places light gray coarsely crystalline, poorly bedded limestone with a few fossiliferous zones

Lodgepole limestone

Woodhurst member

3.	162	Well bedded light gray and buff limestones. Smaller beds ordinarily fine-grained; ledge-formers coarsely crystalline. A few beds red or red-specked. Shale partings thin, yellow, or lavender
4.	113	Blocky red or maroon limestones separated by red calcareous shale partings. Texture predominantly fine, in places coarsely crystalline. Two thin zones of coarse gray-green limestone

	Thickness in Feet	
5.	60	Muddy gray fine-grained limestones separated by 1- to 2-inch bands of yellow shaly limestones. Surfaces of beds irregular and wavy
6.	25	Massive fossiliferous limestone. Texture coarse at top, fine at base. Thin laminae of crinoid fragments.
		Paine member
7.	192	Brown to dark gray predominantly dense limestones separated by thin (1- to 5-inch) shaly partings. Upper strata well bedded and blocky in beds up to 5 feet. Lower strata more thin-bedded and platy. Thin sheets of yellow chert common on joint planes. Numerous bryozoans and brachiopod fragments
8.	20±	Yellowish and light green calcareous shale with zones of black fissile conodont shale
		Three Forks formation. Massive brown sandy limestone

LOGAN

SECTION ON GALLATIN RIVER AT LOGAN, MONTANA

		Amsden sandstone. Sand with limonite cement and red shale
		Mission Canyon limestone
1.	50	Light gray dense massive ridge-forming limestone
2.	20	Massive dense brown limestone interbedded with dark brown more finely bedded zones
3.	100	Massive brown limestones with yellow chert. A few fossiliferous and oölitic zones
4.	10	Dense medium to light gray thin-bedded limestones
5.	50	Massive gray limestone with irregular chert masses and chert stringers along bedding planes
6.	100	Very massive dark olive-brown limstone with large masses of heavy yellow chert and solution cavities filled with calcite crystals
7.	50	Medium gray massive limestone
8.	150	Massive olive-brown dense limestone. Interbedded with zones of massive yellow chert
9.	129	Massive coarsely crystalline brown limestone
10.	45	Massive dense buff to brown limestone with a few fossiliferous zones
11.	49	Zone of massive yellow chert as irregular masses and interbedded with limestones
12.	37	Dense medium gray to buff limestone
13.	32	Ridge-forming limestone. Top coarsely crystalline, medium gray, massive. Base fine-grained
14.	30	Fine-bedded argillaceous and arenaceous dolomitic limestone with zones of brown agate-like chert
15.	60	Medium gray to dark buff, fine-grained at top to coarsely crystalline at base, massive ledge-forming limestones
		Lodgepole limestone
		Woodhurst member
16.	20	Coarsely crystalline crinoidal dark gray limestone with zones of silicified fossils. Calcite veinlets and chert on joint surfaces common
17.	30	Dark gray dense blocky limestones with fine argillaceous partings. A few zones of pink fragmental fossil material on channeled surfaces of beds beneath
18.	50	Very fine-grained dark gray blocky limestones interbedded with irregular thin arenaceous or argillaceous buff stringers. Numerous zones bearing abundant *Schuchertella*
19.	35	Chocolate-brown dense limestone interbedded with gray shaly limestone. Numerous chert nodules and veinlets of calcite
20.	80	Gray and brown massive fine-grained cliff-forming limestones in beds up to 7 feet. Light tan and gray argillaceous and arenaceous partings. Bedding planes and joint surfaces commonly coated with a fine siliceous layer. Numerous dark coarse zones bearing fossil fragments
21.	168	Dark gray to brown, predominantly fine-grained, well bedded limestones bearing abundant brachiopod and crinoid fragments

	Thickness in Feet	
22.	17	Two very prominent ledge-forming dark gray beds of coarse limestone-bearing crinoid fragments
		Paine member
23.	185	Dark gray, in places brown, fine-grained limestone in beds averaging 4–6 inches interbedded with very finely bedded calcareous shales, more massive ledge-forming zone at base. Branching and fenestellate bryozoans common
24.	146	Same as unit 23 above except that shaly zones are more prominent. Lighter gray limestone common near base
25.	0.25	Black carbonaceous sandy shale
		Three Forks formation. Top of Three Forks. Dense massive brown dolomitic sandy limestone. *Spirifer whitneyi*

Bridger Range

SECTION AT FLATHEAD PASS

Amsden formation. Red sandstone

Mission Canyon limestone

1.	125	Medium gray, highly massive, poorly bedded, fine-grained limestone. Irregular solution channels filled with solution or erosion rounded limestone pebbles. A few brown zones of porous sandy limestone
2.	3	Zone of red-stained limestone solution breccia
3.	50	Medium gray to olive-gray fine-grained massive limestone. A few thin bands of greenish brown chert
4.	50	Covered interval. Boulders of limestone conglomerate in float
5.	202	Gray highly massive poorly bedded dense gray limestone forming characteristic castellated erosion forms
		Lodgepole limestone
		Woodhurst member
6.	270	Well bedded dense gray limestones with few thin shaly partings. 3-to 5-foot beds at base, more massive at top. A few zones of crinoid fragments
7.	170	Well bedded, blocky, gray, predominantly fine-grained limestones with 1–2 inches shaly partings separating 2- to 5-foot beds. A few coarse-grained fossiliferous zones. Two 20-foot highly massive beds at base
8.	130	Blocky gray limestone with thin calcareous shale partings separating 1-2-foot beds. A few zones of crinoidal fragments on irregular channelled bedding surfaces. Orthid brachiopods conspicuous near base
		Paine member
9.	230	Dark gray to black dense limestone in 3- to 4-inch beds alternating with 3- to 4-inch beds of gray and brown calcareous shale. Minor amounts of small chert lenticules. Fenestellate bryozoans prominent on weathered limestone surfaces
		Three Forks formation. Orange sandy limestone overlying black, white-weathering limestone bearing typical Three Forks fauna

Quadrant Mountain, Yellowstone National Park

SECTION ON SOUTH FLANK

Amsden formation. Red sandstone and shale

Mission Canyon limestone

1.	230	Medium gray, fine-grained, highly massive limestone with minor amounts of tan chert
2.	124	Dark gray to olive-brown massive fine-grained limestone weathering to light tan. A few finely banded zones
3.	116	Medium gray, massive but clearly stratified limestone. Texture coarse at base, finer near top. A few inconspicuous beds of pebbly limestone
		Lodgepole limestone
		Woodhurst member
4.	122	Brownish buff, predominantly fine-grained limestone in beds up to 5 feet. Fine shale partings. A few coarse zones of fossil fragments.
5.	256	Medium gray, in places brown, predominantly fine-grained blocky limestone in 1- to 3-foot beds separated by 1-3 inches shaly partings. Numerous zones of coarse fragmental crinoid material

	Thickness in Feet	
6.	39	Massive, light gray, cliff-forming, dense limestone without shaly partings. Inconspicuous small chert lenticules. Zone of crinoid fragments near top Paine member (?)
7.	56	Dark gray to black, extremely fine-grained cliff-forming limestone split into 3-inch beds by numerous bands of black chert about 1 inch thick

Cooke City

SECTION ON SOUTH SIDE OF SODA BUTTE CREEK
1 MILE WEST OF COOKE ENTRANCE TO YELLOWSTONE PARK

		Tertiary pyroclastics. Coarse agglomerates bearing boulders of Paleozoic limestones. Lie with pronounced unconformity on maturely eroded surface of Madison group
		Mission Canyon limestone
1.	49	Highly massive cliff-forming limestone composed almost entirely of fragmental fossils, chiefly crinoid columnals and brachials
2.	93	Massive, light tan, buff, and light chocolate-brown fine-grained limestone
3.	10	Well bedded limestone with numerous grape-purple stained zones bearing abundant crinoid fragments and *Schuchertella* (?)
4.	64	Massive, cliff-forming, light tan to buff fine-grained limestone. Few round nodules of light buff chert
		Lodgepole limestone
5.	100	Well bedded blocky gray limestones in beds up to 5 feet separated by thin shaly partings. A few coarse-grained zones of crinoid fragments
6.	218	Well bedded and blocky as above but in 1- to 2-foot beds. Coarse crinoidal zones more numerous
		Three Forks formation
7.	5	Thin-bedded brown limestone with abundant *Atrypa*
8.	10	Green shale
9.		Medium brown massive limestone in beds up to 10 feet. *Atrypa, Phillipsastraea*

Pryor Mountains

SECTION MEASURED ON DRY HEAD CREEK NEAR JUNCTION WITH BIG HORN RIVER

		Amsden formation. Red shale and sandstone. Light gray limestone with red and purple spots. Ten-foot limestone conglomerate with white limestone pebbles grading upward to fragmental fossil material. White fossil fragments with pink flecks
		Mission Canyon limestone
1.	90	Yellowish white-to-cream medium-textured massive limestone. Weathering along joints and bedding planes, imparts blocky appearance to cliff
2.	50	Zone of pink-stained solution breccia filling large solution cavities in light gray and cream-colored massive limestone
3.	100	Cream to white massive saccharoidal limestone. Fresh cliff surfaces massive, weathered surfaces exhibit well defined bedding planes
4.	75	Cream-white massive limestone as above but with more apparent stratification
		Lodgepole limestone
5.	40	Light gray limestone in 1- to 6-inch beds. Weathers to form prominent finely laminated concavity above which rise Mission Canyon cliffs
6.	47	Gray, predominantly fine-grained blocky limestone in 1- to 2-foot beds separated by thin shaly partings. Weathering produces finely banded effect
7.	5	Massive gray ledge-forming limestone
8.	33	Blocky, predominantly fine-grained limestone in beds to 2 feet, 6 inches. Minor amounts of gray and white chert
9.	12	Massive, ledge-forming, dense light gray limestone
10.	12	Soft white limestone with chalky texture

	Thickness in Feet	
11.	130	Light gray blocky limestone in 1- to 4-foot beds separated by thin shaly partings. A few brownish gray saccharoidal zones. (Base not exposed, but examination of other sections in uplift indicates that disconformable contact with Big Horn dolomite should be within 30 feet.)

GALLATIN RANGE

SECTION ON SHEEP ROCK NEAR GALLATIN GATEWAY, MONTANA
SECTION TERMINATED BY THRUST BRINGING MADISON AGAINST SCHIST AND GNEISS

		Mission Canyon limestone
1.	150±	Light yellowish buff and gray, very massive coarsely crystalline limestone
2.	5	Zone of ochre limestone breccia. Apparently of normal sedimentary deposition but probably stream deposited along solution channel
3.	169	Light yellow to gray coarsely crystalline massive limestone in beds up to 20 feet
		Lodgepole limestone
		Woodhurst member
4.	40	Dark gray massive limestone differentiated from Mission Canyon above by more apparent stratification and few zones of crinoid fragments
5.	100	Dark gray, predominantly fine-grained limestone in massive beds up to 10 feet separated by very thin shaly partings. Conspicuous zones of red-staining fragmental fossil material
6.	50	Blocky dark gray limestone in beds up to 10 feet. One to 2 inches red and yellow shale partings stain Woodhurst part of cliff. Coarse-grained fossil fragment zones form prominent massive ledges
7.	35	Blocky limestones and shale partings as above but more finely bedded. Conspicuous red and orange staining
8.	15	Massive gray limestone with only very minor shale partings. Few coarse-grained zones of fragmental fossil material
		Paine member
9.	31	Gray, very fine-grained limestone in 2- to 3-inch beds interbedded with equal amounts of shaly, finely banded saccharoidal limestone or yellow arenaceous shale. Minor amounts of chert
10.	33	Interbedded dense gray limestone and shaly strata as above but more finely bedded and without chert. One-foot zone of fragmental fossil material at top
11.	115	Interbedded dense brownish gray limestone in beds up to 8 inches and 1–3 inches finely bedded red or yellow shaly limestone. Minor amounts of thin olive chert lenticules. Shaly strata impart orange stain to cliffs
12.	20±	Covered interval
		Three Forks formation. Top of formation is thin-bedded brown limestone with beds of green shale. Massive cliff-forming chocolate-brown limestone below

GEOLOGIC HISTORY

It is apparent that in much of the area the separation between Devonian and Mississippian sedimentation was marked by the withdrawal of limestone-depositing seas and by the deposition of organic shales in widespread, but probably more or less isolated, shallow basins. This was followed by the invasion of a sea from the west into a shallow east-west trough extending through central Montana. In the western part of the trough the sea was subject to periodic influxes of clastic matter which was deposited as the shale laminae of the Paine. At the southeast no Paine deposition took place over an area which was also devoid of Devonian and Silurian sediments.

During Woodhurst time the sea overlapped Ordovician and older

rocks in southern Montana and Wyoming. Uniform sedimentation prevailed throughout the area with much less clastic material being deposited. Incomplete stratification resulted in the concentration of crinoidal and brachiopod debris in thick beds.

The Madison sea probably reached its greatest extent in Mission Canyon time. Almost pure limestone was deposited under stable conditions, except in southern Wyoming where a marked increase in clastic content indicates that high portions of the Uinta-Front Range element were locally emergent.

In middle Valmeyer time the sea withdrew to the center of the depositional basin where evaporate beds[21] transitional to Big Snowy sedimentation appear to have been deposited in a remnant sea. Elsewhere the Mission Canyon limestones were laid bare to solution action and subaerial erosion during part of middle and late Valmeyer time. In late Valmeyer and early Chester time the Big Snowy sea in Montana and the Sacajawea sea in Wyoming renewed sedimentation above the Madison leaving exposed a narrow island or peninsula along the Montana-Wyoming border until late Chester or early Pennsylvanian time. On the south and southeast, erosion continued until Pennsylvanian time as indicated by the position of the Fountain beds over the pre-Cambrian in the Laramie[22] and Front ranges of Wyoming and northern Colorado, and the Minnelusa (?) over the pre-Cambrian[23] on the Cambridge arch in northwestern Nebraska. That the Madison, although probably thin, once extended over most of this area is evidenced by Madison boulders in the basal Pennsylvanian conglomerate. North of the Belt and Big Snowy mountains of Montana, Mesozoic erosion also attacked Madison sediments, and in northern Alberta and most of Saskatchewan it removed them completely before mid-Jurassic time. The sequence of events may be outlined as follows.

1. Local withdrawal of Devonian sea and marked changes in sedimentation and fauna
2. Deposition of organic shale transition beds in shallow isolated basins
3. Invasion of Paine sea from west into shallow east-west trough through central Montana. Deposition of Paine beds in sea subject to periodic influxes of clastic matter from west. No deposition in southeast over an area also lacking Silurian and Devonian strata
4. Further spread of sea north and south, and uniform deposition of Woodhurst beds. Clastic material diminishes and indirect stratification active with concentration of crinoid and brachiopod fragments in thick beds
5. Farthest spread of sea and deposition of Mission Canyon limestone. Complete absence of sand and silt except in southeast margin of basin

[21] G. R. Downs, personal communication (1941).

[22] G. E. Condra, E. C. Reed, and O. J. Scherer, "Correlation of Formations of the Laramie Range, Hartville Uplift, Black Hills and Western Nebraska," *Nebraska Geol. Survey Bull. 13* (1941), pp. 8, 10, 11.

[23] O. A. Seager, personal communication (1941).

6. Withdrawal of sea. Exposure to subaerial erosion and solution action during part of middle and late Valmeyer time
7. Transgression of late Valmeyer and early Chester seas. Deposition of Big Snowy sediments in central Montana, Sacajawea in northern Wyoming. Collapse and filling of caverns and channels. Continued erosion in area of Montana-Wyoming border. Stripping of Madison from northern flanks of Uinta-Front Range element (Wyoming-Colorado) and Cambridge arch (Nebraska)
8. Deposition of later Paleozoics (and Triassic in south)
9. Early Mesozoic erosion north of present Big Snowy and Belt mountains, Montana, to form karst topography on the Madison where exposed. Madison completely removed in northern Alberta and northern Saskatchewan
10. Deposition in Jurassic of Fernie, Ellis, Sundance

RESERVOIR ZONES

Zones of sufficient porosity and permeability to serve as reservoirs for commercial quantities of petroleum are confined to the Mission Canyon limestone. Such zones appear to have resulted from one or more of five causes.

1. Solution by surface and ground waters during pre-Jurassic exposure of the Mission Canyon to erosion
2. Dolomitization by epigenetic replacement
3. Sandy zones sufficiently free of argillaceous and calcareous silts to have normal sandstone characteristics
4. Reworking of oölitic and granular material by currents with subsequent secondary deposition as calcite sand and with resulting increase in pore space
5. Fracturing, which, although not of sufficient importance to be sole cause of productive zones, may have been controlling factor in determining local highly productive areas within zones formed by one or more of four other causes

Solution work, as might be expected, is most important in the area of the Sweetgrass arch where pre-Jurassic erosion laid bare a large area of Madison limestone. In the Kevin-Sunburst field most of the oil production comes from the upper 10 feet of the limestone where solution is in large part responsible for the porosity.[24] There are, however, isolated instances of large production as deep as 135 feet below the Ellis contact. Three reservoir types are observed in cores and in fragments blown from wells.

1. Loose rubble of insoluble material, partly dissolved limestone pebbles, and poorly consolidated calcite silts and sands locally known as "Ellis sand," occurs at contact of Mission Canyon limestone and overlying Ellis formation. This may be considered type of "solution lag gravel" produced in late stage of cycle of ground-water erosion during which the surface was lowered, sediments reworked, and less soluble material concentrated
2. Siliceous material, largely chert and silicified fossils from which calcite has been dissolved. Such material would result from solution of calcite in numerous cherty zones of Mission Canyon
3. Brown spongy dolomite with pore spaces formed of skeleton calcite crystals. Extremely porous and permeable rock, which is most important reservoir rock in field, is probably due to differential solution of calcite from partly dolomitized limestone

It may be pointed out that in each case reservoir conditions are

[24] Eugene S. Perry, "Kevin-Sunburst and Other Oil and Gas Fields of the Sweetgrass Arch," *Montana Bur. Mines and Geology Mem. 1*, 2d ed. (1929), p. 15.

formed in zones containing sufficient insoluble material to carry the load of the overlying strata after the removal of soluble calcite. Large open cavities are rare (although at least one has been encountered in drilling); their absence may be explained by the collapse or filling of caverns and sinks prior to the deposition of the Ellis. Where such cavities are filled by sand or breccia, reservoir potentialities might be expected, and, although there is no real evidence to prove it, some of the extremely localized productive areas in the Kevin-Sunburst field may be thus explained.

In the Turner Valley field of Alberta oil production is largely confined to three porous zones in the upper 400 feet of the Rundle (Mission Canyon) limestone as follows.

1. Thin zone of minor importance at contact with superjacent Fernie formation (Jurassic) approximately corresponding in position and character with major productive zone at Kevin-Sunburst
2. "Upper Porous zone" approximately 100 feet below Jurassic contact and approximately 100 feet thick
3. "Lower Porous zone" about 350 feet below Jurassic and approximately 80 feet thick. Not persistent in central part of field

Mackenzie[25] states that "in all Paleozoic samples from Turner Valley, porosity is everywhere associated with dolomitization." This process has resulted in the formation of a profusion of voids "a very few of which might be $\frac{1}{4}$ inch in diameter, but the great majority are less than 1/16 inch."[26] Bartram[27] describes similar porous conditions in the Garland field of Wyoming where fine-grained dolomites have developed voids "as large as a pinhead or larger." Perry,[28] dealing with the development of porosity by dolomitization in the Kevin-Sunburst field, suggests that replacement of the calcite molecule by the smaller dolomite molecule caused a reduction in volume and the consequent development of pore space. It would seem probable that such replacement and formation of open voids could not be the result of diagenetic processes which would occur before the rock had sufficient strength to maintain voids. The replacement must therefore be considered as epigenetic. It is significant that pore-forming dolomitization is most important in areas in which the Madison is involved in unconformable relationships with overlying strata—the result of pre-Jurassic erosion on the Sweetgrass arch and of late Valmeyer and early Chester erosion in northern Wyoming. Does it not appear possi-

[25] W. D. C. Mackenzie, "Paleozoic Limestone of Turner Valley, Alberta, Canada," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24 (1940), p. 1626.

[26] *Ibid.*, p. 1629.

[27] J. G. Bartram, "Characteristics of Producing Sandstones and Limestones of Wyoming and Montana," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 16 (1932), p. 868.

[28] Perry, *op. cit.*, p. 16.

ble that ground-water circulation during periods of exposure may account for the dolomitization?

The Madison is predominantly sandy near the southern border of the Madison depositional basin in Wyoming from the Salt Creek field south. This change in lithologic facies is almost certainly related to a Paleozoic positive area upon which an overlapping fringe of Madison was deposited not far north of the Colorado-Wyoming boundary. Erosion of sandstones and crystalline rocks exposed during Madison time on the positive area accounts for a bordering sandy shore-line phase and the accompanying porosity of the Madison.

Granular limestones composed of saccharoidal grains, and more rarely oölites, commonly form cross-laminated zones in the massive members of the Mission Canyon limestone. This calcite sand is far more porous than the normal limestones, and although there is no recognized oil production from such cross-laminated zones, it seems entirely possible that initial porosity of this type might permit the circulation of waters which would cause the selective dolomitization or solution of certain beds. This is one possible explanation of the marked correspondence of leached and dolomitized zones with stratigraphic horizons within the limestone.

Development of fractures, mainly joints, is probably a contributing factor to the reservoir zones formed by other processes. Fractures would form conduits for the initial entry of leaching or dolomitizing waters, and the action of such waters would spread laterally from the fractures. An intersecting network of closely spaced fractures could thus control an area of high porosity, while a similar adjacent unfractured area would remain "tight" and but little altered. This relationship of fracturing to porosity may possibly explain the very irregular distribution of production in the Kevin-Sunburst field where dry offsets may be drilled next to highly productive wells.

In order to determine the per cent of effective porosity to be expected in various rock types, tests were made on relatively unweathered samples taken from outcrops of the Mission Canyon. Inasmuch as samples with a readily apparent porosity were selected it is probable that average values for each type are lower than those given.

Rock Type	*Percentage Effective Porosity*
Dolomite, voids formed by molds of calcite crystals and fossils	27.8
Dolomite, impure, fine-grained	21.8
Dolomite, pure, fine-grained	21.7
Limestone, dolomitic, saccharoidal	19.8
Limestone, pure, coarse-grained	17.0
Dolomite, stylolitic	16.6



FIG. 7.—Reddish brown Amsden sandstone (*S*) filling solution channel 200 feet below top of Mission Canyon limestone. Yellowstone River southwest of Livingston, Montana.

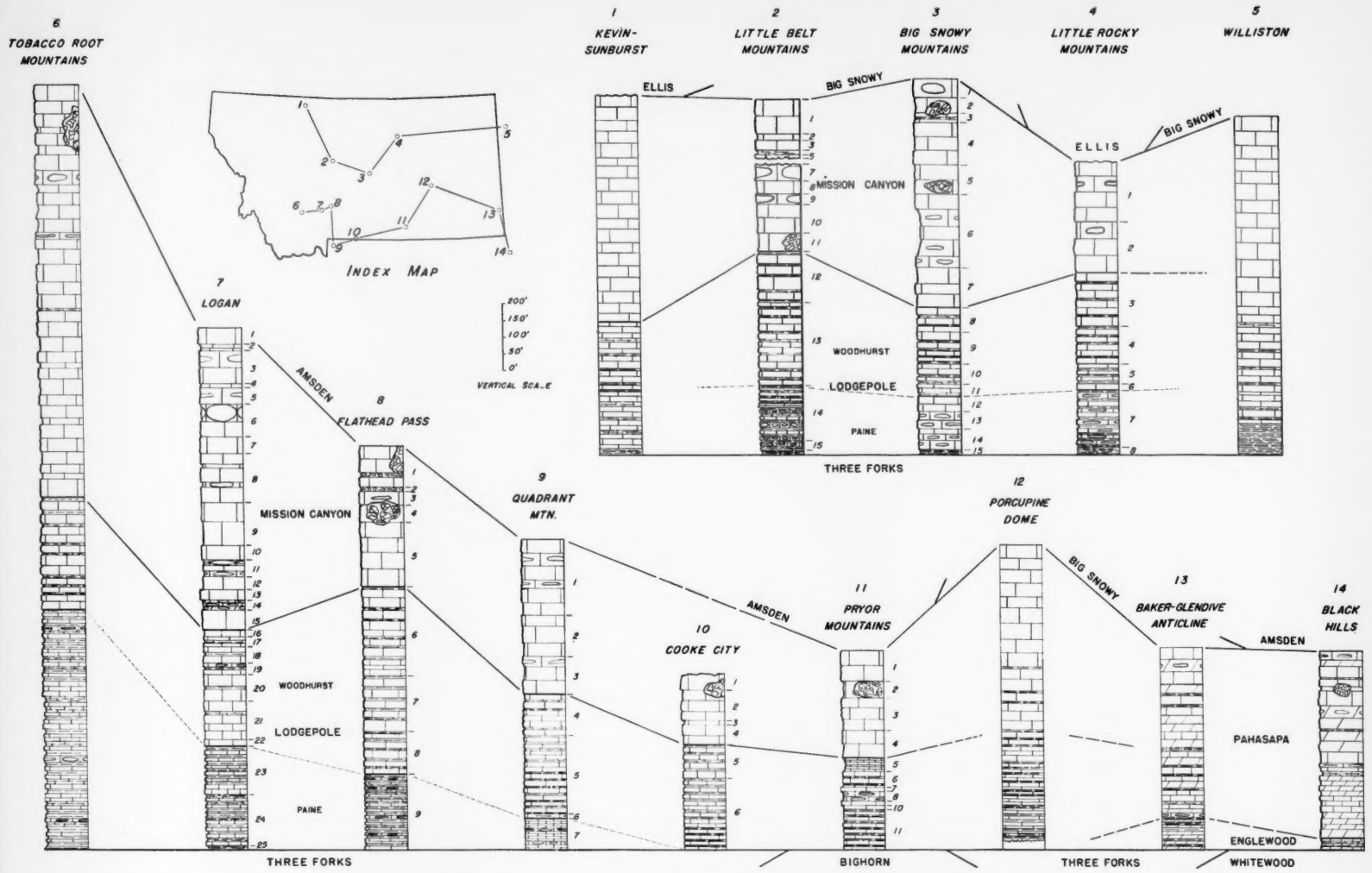
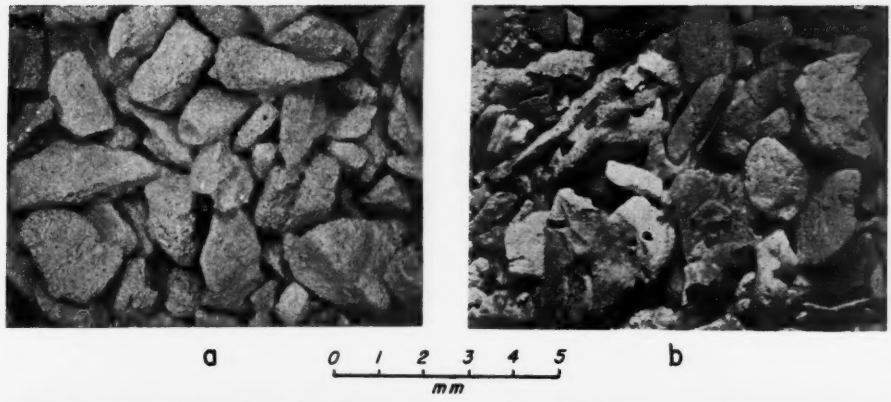
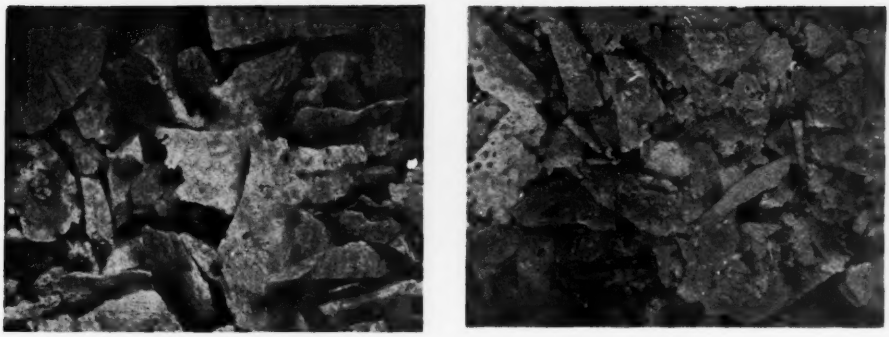
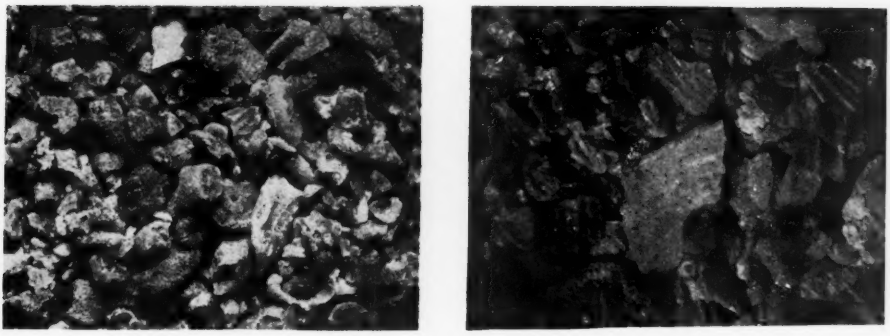


FIG. 8.—Columnar sections of Madison group in Montana. Numbers of lithologic units correspond with those in descriptions of sections.





PAINE MEMBER



WOODHURST MEMBER

LODGEPOLE LIMESTONE

FIG. 9.—Typical insoluble residues from Madison limestones. a. Spongy clay pellets from Paine member at Logan, Montana. b. Clay pellets and angular chert fragments from Paine member in Little Rocky Mountains. c. Dolocastic chert from Paine member in Little Belt Mountains. d. Bryozoan and brachiopod débris from Paine member in Big Snowy Mountains. e. Crinoidal débris from Woodhurst member at Logan, Montana. f. Crinoid and brachiopod fragments from Woodhurst member in Big Snowy Mountains.

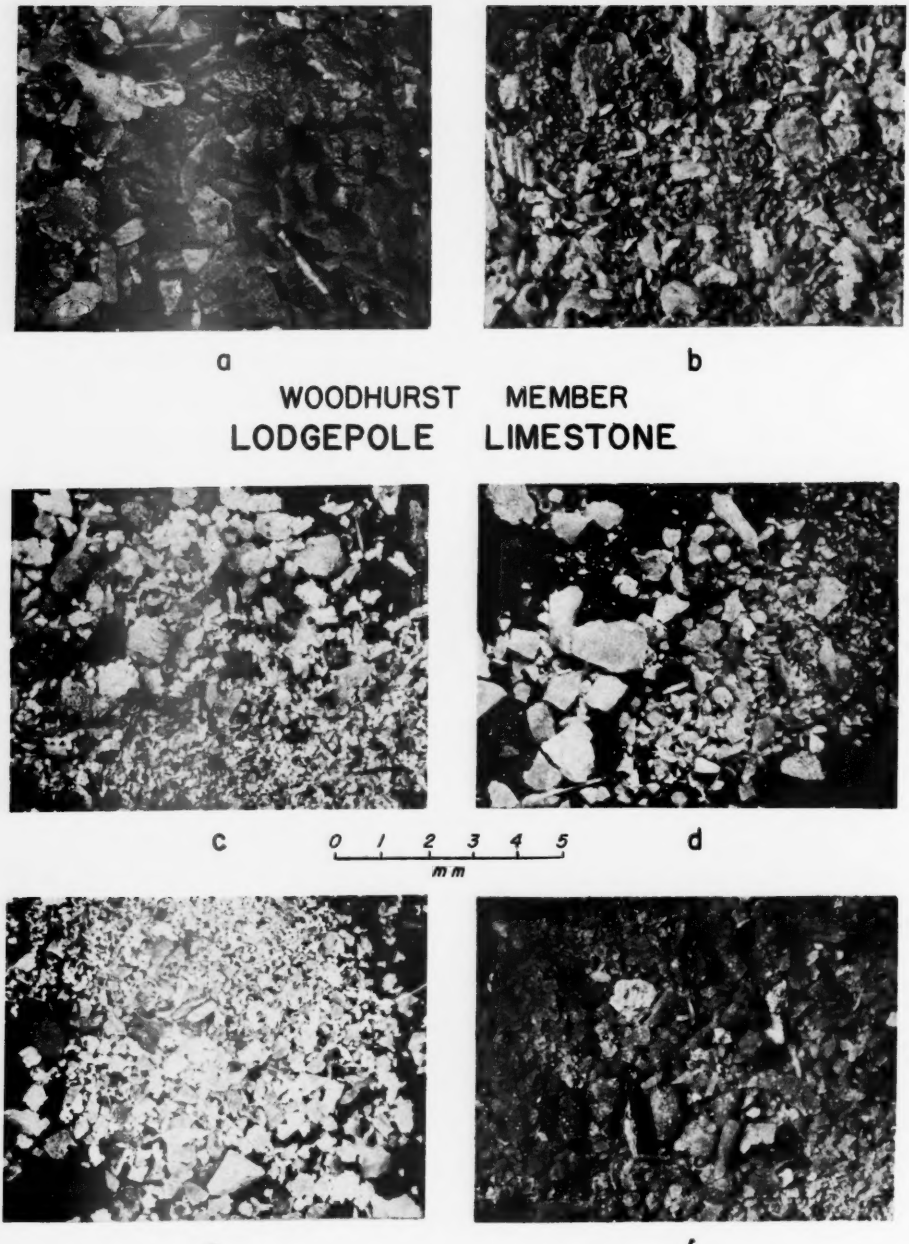


FIG. 10.—Typical insoluble residues from Madison limestones. a. Fossil fragments from Woodhurst member in Big Snowy Mountains. b. Fossil fragments and quartz sand from Woodhurst member in Little Rocky Mountains. c. White chert and limonite from Mission Canyon limestone in Little Rocky Mountains. d. White chert from Mission Canyon limestone in Little Belt Mountains. e. White chert and limonite from Mission Canyon limestone in Gravelly Range. f. White chert and brown drusy quartz from Mission Canyon limestone in Little Rocky Mountains.

Tests were also made on porous fragments blown from wells in the Kevin-Sunburst field. Results of tests on two rock types are here given.

Rock Type	*Percentage Effective Porosity*
Dolomite, finely spongy	55·3
Chert and silicified fossils	30·4

INSOLUBLE-RESIDUE ANALYSIS

The samples on which the insoluble-residue analysis is based were taken at designated intervals, usually 5 feet, from outcrops during the course of measurement of sections. All samples may therefore be accurately located with respect to stratigraphic horizons. Samples were digested in thirty per cent warm hydrochloric acid, a procedure which perhaps destroyed certain features of the residues, but which was sufficiently rapid to make possible the handling of large numbers of samples.

Examination of the residues indicates that no single residue constituent is diagnostic of any stratigraphic horizon, nor is any single sample sufficient to identify a horizon. Suites of residues examined with respect to all constituents are necessary for the identification or differentiation of stratigraphic units. It is possible, however, to make the following general statements regarding the formations and members involved.

MADISON GROUP

Mission Canyon limestone.—The Mission Canyon is characterized by extremely small residues, from a few grains to two per cent of the original sample, except where massive chert zones are encountered. Snow-white chert, accessory minerals (magnetite, tourmaline, ilmenite, zircon, garnet, biotite, and muscovite), and sand grains make up the bulk of most samples. One persistent zone contains clusters of fine brown quartz crystals; a few zones rich in silicified fossils are found.

Lodgepole limestone (*Woodhurst member*).—Woodhurst residues characteristically contain large amounts of silicified fossil fragments (crinoid columnals and brachials, brachiopod shells and spines, echinoid spines, hexactinellid spicules). A few zones are represented by large amounts of sub-rounded sand grains. Oöloid clusters and oölitic grains are common.

(*Paine member*).—Paine residues, as might be expected, contain large amounts of argillaceous matter occurring as clay pellets bearing dolocasts and fossil impressions. Masses of mottled tan and gray chert

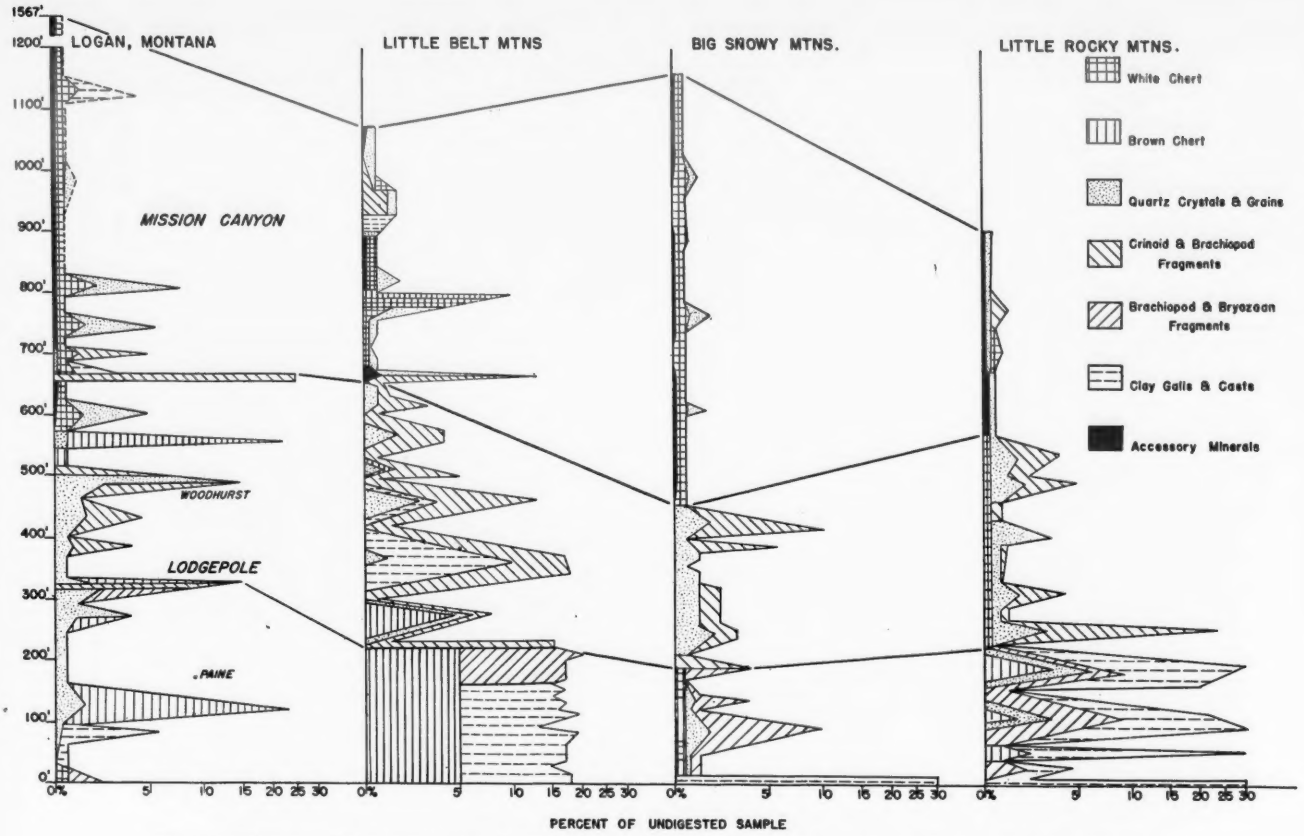


FIG. 11.—Diagrammatic representation of insoluble-residue characteristics from four sampled sections of Madison group. Percentages shown refer to amounts of original undigested samples recoverable as insoluble residues.

bearing silicified bryozoans are also characteristic. Some zones carry large amounts of monactinellid and hexactinellid spicules and silicified brachiopod fragments.

OTHER FORMATIONS

Other Paleozoic limestone may be confused with the Madison in cores, drill cuttings, or fault blocks. The following brief descriptions may aid in their identification.

Three Forks limestone.—The widespread limestone facies of the Three Forks produces residues characterized by aggregates of sand grains except in the Little Rocky Mountains where flakes and casts of limonite are dominant.

Jefferson dolomite.—Residues from the Jefferson are characterized by white, delicate lace-like siliceous dolocasts.

Bighorn dolomite.—Bighorn residues are easily confused with those of the Mission Canyon, but differ most notably in their larger volume. Although other differences are difficult of description, differentiation is not a serious problem in practice.

Amsden formation.—Insufficient study has been made of the Amsden limestone to describe in detail. However, red colorations, red sand grains, white siliceous fossil fragments, and pink argillaceous silt were noted in several samples. In general Amsden residues are characteristically different from those of the Madison.

Insoluble-residue analysis indicates that suites of residues make possible the correlation and identification of the major stratigraphic units in the entire area covered by the writers. In limited areas, zones within the members and formations are capable of recognition and correlation if a sufficiently large suite of samples is analyzed. Recognition of such zones may not, however, be expected to extend beyond a distance of 50–100 miles.

The writers' investigation indicates that the amount of residue derived from a given weight of sample is ordinarily diagnostic in differentiating Mission Canyon from Lodgepole residues. It must be recognized, however, that widely varying results may be obtained in treating samples rich in argillaceous material, depending on the extent to which shale particles are broken down and decanted.

The following are condensed descriptions of the residues of the four sections most intensively studied by the writers. The amount of the residues is indicated as percentage by volume of the original undigested sample. Although shales and cherty zones may produce residues amounting to 90 per cent of the sample, amounts in excess of 30 per cent are not entered in the descriptions or the diagrams (Fig. 11).

DESCRIPTION OF RESIDUES

LOGAN, MONTANA

MISSION CANYON LIMESTONE

Depth in Feet	*Amount of Residue (Percentage)*	
		Top of Madison
0–733		No samples
–741	1–17	Tan encrusting quartz crystals, brown chert oöloids, minute quartz grains, fragments of white chert, accessory minerals
–780	1–25	Clay casts which when broken down would probably yield minute quartz grains, fragments of white chert, accessory minerals
–795	1	Minute quartz grains, fragments of white chert, accessory minerals
–800	1	Fragments of white chert, chert oöloids, minute quartz grains, accessory minerals
–855	1–8	Minute quartz grains, fragments of brown and white chert, accessory minerals, clay appears in places in form of casts
–861	2	Clay casts, fragments of chert
–866	6	Fragments of fossils replaced by chert (brachiopod spines, crinoids), fragments of white and brown chert
–875	6	Minute quartz grains, fragments of brown and white chert
–880	2	Masses of clear quartz crystals, encrusting chert, tan chert, fragments of fossils replaced by quartz
–890	3–10	Clay, mainly in form of casts, and brown chert fragments
–900	13–15	Same as above

LODGEPOLE LIMESTONE

Woodhurst member

–905	20	Entirely made up of fragments of fossils, mainly crinoids, replaced by chert and quartz
–946	1–2	Fragments of gray chert, minute quartz grains, few oöloids, some milky quartz and a few accessory minerals
–951	6	Masses of pink to white chert, masses of clear quartz, fragments of brachiopods replaced by chert
–991	1–3	Minute quartz grains, fragments of white chert, accessory minerals few if any
–1,001	3–5	Gray chert casts, masses of light gray chert, fragments of chert, few accessory minerals
–1,006	23	Dark gray to black chert
–1,026	1	Minute quartz grains, fragments of white chert, accessory minerals
–1,046	1	Few fragments of chert, some of which are dolocastic, few fossil fragments and accessory minerals
–1,061	1–3	Almost entirely fragments of fossils: ostracods, echinoid spines, corals, *et cetera*
–1,071	1	Mainly minute quartz grains some of which are rounded; aggregates of sand grains and light gray casts, accessory minerals common
–1,229	1–6	Sand grains, fossils fragments. A few samples largely fossil fragments, one or two with the Paine type of clay casts, in some samples gray chert appears
–1,239	12–15	Mainly brown chert, quartz grains
–1,244	2	Clay pellets, few leached chert fragments
1,246	1–10	Fossil fragments in large amounts, very little sand

Paine member

–1,266	1–5	Sand grains and silicified fossil fragments
–1,291	1–4	Mainly sand grains, small amount of chert

Depth in Feet	*Amount of Residue (Percentage)*	
-1,416	1	Small amounts of argillaceous material, sand grains, dark chert, and few accessory minerals
-1,471	1-23	Mainly argillaceous casts, a few quartz grains
-1,476	2	Dark gray chert with a granular appearance, a few quartz grains, and a few accessory minerals
-1,492	1-6	Mainly argillaceous material, some forming casts, few quartz grains and chert fragments
-1,528	1-3	Argillaceous material, quartz grains, few chert fragments
-1,549	1	Fragments of chert; argillaceous material, spicules, accessory minerals
-1,561	1-23	Fragments of tan and gray chert, quartz grains, accessory minerals, spicules, fenestellate bryozoans
-1,567	1-2	Mainly fragments of white chert, quartz grains, fragments of fossils replaced by silica, limonite, glauconite. Argillaceous material is more or less present according to amount removed in process of acid treatment

LITTLE BELT MOUNTAINS

MISSION CANYON LIMESTONE

		Top of Madison
0-105	1-20	Either fine quartz grains or flat irregular finely crystalline quartz fossil replacements dominant. Characteristic color light tan. Accessory minerals present at top, less farther down. Chert zones appear as large residue samples with irregular fragments of tan chert, a few zones of snowy white oölites
-125	5	Very light tan quartz grains
-155	1-10	Increase in amount of residue caused by appearance of larger quantities of tan silicified fossil fragments, fine quartz grains less common, one zone of aggregated oölites with characteristic white chalky coating.
-165	7	Argillaceous zone, light buff clay pellets
-175	1	Tan irregular crystalline quartz masses
-265	1	White or light gray chert fragments, fine quartz crystals, spongy pumice-like casts, few accessory minerals, one zone of tan irregular crystalline quartz masses
-280	1-20	Mainly tan chert
-285	1	Fine quartz grains and cream-colored porous chert
-295	5	Almost all cream-colored masses of porous chert
-385	1	White chert, irregular masses of clear quartz crystals, a few silicified fossil fragments, few pumice-like casts
-395	13	All light buff spongy casts
-405	1	Small masses of quartz crystals, fragments of clear quartz, light buff pumice-like casts, numerous accessory minerals
-415	1	Mainly white silicified brachiopod and bryozoan fragments, small irregular quartz masses
-455	1-3	Irregular quartz crystal masses, light gray chert, pumice-like buff casts, occasional silicified brachiopod fragments

LODGEPOLE LIMESTONE

Woodhurst member

-485	1-3	Sand grains White fossil fragments, chiefly brachiopods
-495	4	Tan argillaceous material, white silicified fossil fragments
-505	4	Sand grains, clear quartz fragments, fossil fragments, chiefly brachiopods
-525	1-4	Argillaceous casts, fossil fragments (brachiopods)
-545	1	Few chert fragments, sand grains, accessory minerals
-561	1-3	Tan chert, sand grains, few fossil fragments, tan encrusting quartz

Depth in Feet	*Amount of Residue (Percentage)*	
−566	5	Fossil fragments, tan encrusting quartz, sand grains
−582	1	Sand grains, spicules
−617	1–13	Silicified fossil fragments, oölоids, sand grains
−627	7	Dolocastic chert
−677	1–11	Silicified fossil fragments (brachiopods), spicules, white chert, some argillaceous material
−687	5	Argillaceous material
−697	17	Tan chert
−712	13–18	Argillaceous material
−717	30	Dolocastic chert, spicules
−737	18	White and gray chert
−759	1–7	Argillaceous material
−779	1	Snow-white quartz, sand grains, few fossil fragments
−839	1–2	Tan chert, quartz crystals, few argillaceous worm tubes, white quartz fragments, few fossil fragments, crinoids, fenestellate bryozoans
−849	15	Fossil fragments, mainly crinoids replaced by granular quartz
		Paine member
−909	15–20	Fragments of gray to tan chert in which large amounts of fenestellate bryozoans are found
−1,009	13–20	About equal amounts of argillaceous pellets and casts and black mottled chert
−1,049		No samples
		BIG SNOWY MOUNTAINS
		MISSION CANYON LIMESTONE
0–64	1	Top of Madison. Sand grains, accessory minerals, fragments of white chert
−96	1	Fragments of white chert, sand grains, oölites covered with tan drusy quartz.
−682	1	Fragments of white and tan chert in minute amounts, small amounts of accessory minerals, rounded sand grains
		LODGEPOLE LIMESTONE
		Woodhurst member
−696	1	Mainly sand grains, irregular and sub-rounded. A few tiny fragments of fossils (crinoids, brachiopods), traces of accessory minerals
−766	2–10	Fossil fragments, white quartz, few sand grains
−966	1–4	Sand grains very abundant, making up most of the residues, few residues with large amounts of fossil debris (bryozoans)
−976	4	Almost entirely silicified fossil fragments (brachiopods, crinoids)
		Paine member
−1,128	1–10	Residues not the ordinary Paine type. Ordinary clastic material not present in large quantities. Residues mainly fossil fragments, clusters of quartz grains. A few samples have tan chert, fragments of white chert very common, sand grains are present in a few, spicules of various types
		LITTLE ROCKY MOUNTAINS
		MISSION CANYON LIMESTONE
0–230	1–2	Top of Madison. Irregular masses, in many places fossil fragments of sub-transparent crystalline quartz. Next in order of abundance are minute quartz grains, most of them clear and angular; porous limonite masses, plates of muscovite
−326	1	Drusy and irregular quartz masses; larger relative amounts of minute angular quartz grains. Accessory minerals abundant

LODGEPOLE LIMESTONE

Woodhurst member

Depth in Feet	*Amount of Residue (Percentage)*	
−331	2	Contact marked by abrupt appearance of chalky fossil fragments. Some samples almost 100 per cent clastic matter. Residues from certain limestone beds very similar to Mission Canyon, but ordinarily contain more fossil fragments
−354	1–4	White chert fragments, sand grains, encrusting quartz, limonite, white chert more conspicuous at top of unit, encrusting quartz near base, numerous fossil fragments, mainly crinoids
−361	1	Sand grains, small amount of clastic material, white chert, small quantity of fossil fragments
−396	1–4	Residues red in color, white chert flakes, fossil fragments, limonite, few accessory minerals
−406	5	Snow-white chert encrusting quartz, fossil fragments, limonite
−419	1–3	Snow-white chert, white oöloids, sand grains, few brownish masses of sand grains, snow-white silicified fossil fragments
−429	2	White chert, fossil fragments, limonite, spicules
−439	1	White quartz crystals, white chert, sand grains, accessory minerals, spicules
−478	1	Red-colored sand grains, snow-white chert, white chert oöloids, limonite, few accessory minerals, spicules
−483	1	Snow-white chert, spicules, limonite
−493	1	Rounded sand grains, white chert, accessory minerals
−498	3	Casts consisting of aggregates of sand grains, few red limonite grains
−508	1	Increase in intensity of red-colored sand grains, red chert, fossil fragments, few accessory minerals
−576	1	Reddish sand grains, few accessory minerals, brachiopod spines, few fragments of white chert
−586	4	Casts made up of red sand grains, chert, fragments of fossils (bryozoans, brachiopods), white chert fragments
−596	1	Reddish sand grains, few accessory minerals, few fragments of fossils
−606	2	Clastic material, accessory minerals, chert fragments, few fragments of fossils (bryozoans), limonite
−636	1	White chert, fossil fragments, sand grains, accessory minerals
−646	25	Large amount of fossil fragments, chert, siliceous casts
−656	1	Fragments of white and gray chert, sand grains, few fossil fragments, spicules
−666	8	Euhedral quartz crystals, many oöloids, fragments of chert, fragments of fossils
−681	1	Sand grains abundant, some white chert, accessory minerals, few fragments of gray and white chert
		Paine member
−691	2–8	White chert fragments, fossil fragments, oöloidal chert, clear quartz, some crystalline, few spines, some chert in cast form, sand grains conspicuous near top of unit
−701	5–17	Fragments of white and gray chert, some argillaceous casts, spines and spicules, fossil fragments
−873	1–30	Argillaceous material, few sand grains, carbonaceous material, spicules, spines, chert fragments with bryozoans near top of unit
−882	2	White and tan chert fragments, white quartz, pyrite
−885	30+	Gray and black shale
−887	30+	Clay, white chert, accessory minerals
−888	30+	Black shale

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VOL. 26, NO. 3 (MARCH, 1942), PP. 336-379, 6 FIGS.

STRATIGRAPHY OF NORTH DAKOTA[1]

VIRGINIA H. KLINE[2]
Ann Arbor, Michigan

ABSTRACT

The entire geologic section for North Dakota is not yet known, but all systems, except possibly the Cambrian, are known to be represented. Pre-Mississippian formations underlie the Lake Agassiz silts in the Red River Valley and are continuous with outcrops in the Winnipeg area. Canadian formation names have been applied to these. Rocks of Mississippian through Jurassic age are present only in the western half of the state, are known only from a few samples and well logs, and are everywhere overlapped by Cretaceous rocks. Upper Cretaceous and Tertiary rocks form the bedrock surface over most of the state. In most places they are overlain by a thin mantle of drift.

INTRODUCTION

In preparing this report a study was made of all available well samples, drill cores, and well logs from North Dakota and closely adjacent areas. Additional unpublished information was obtained from the late Howard E. Simpson, Frank C. Foley, and Frederick W. Voedisch. Also, a total of about four weeks was spent in the field examining outcrops east of the Missouri River.

An attempt is made to summarize briefly the lithology and distribution of all formations within the state. Descriptions of the Lance and Fort Union have been drawn in large part from the reports of A. G. Leonard, former State geologist, since they were studied in great detail by him in the area west of the Missouri River. The White River outcrops were not seen, the description of that formation being taken largely from Leonard's publications. *Bulletin 775* of the United States Geological Survey, "Geology and Lignite Resources of the Marmouth Field, Southwestern North Dakota," by C. J. Hares, was drawn upon freely also. On the accompanying map the formations west of the Missouri and above the Fox Hills are shown essentially according to Leonard.

PRE-CAMBRIAN

Information concerning rocks of pre-Cambrian age in the state is meager. A number of wells, chiefly in the Red River Valley, have been drilled into "granite," but few samples of these have been kept.

The most extensive drilling into the pre-Cambrian has been in and around the city of Fargo. Logs of a number of these wells have been published,[3,4] and samples of additional wells are filed in the offices of

[1] Manuscript received, October 23, 1941.

[2] 1004 S. Forest.

[3] Howard E. Simpson, "Geology and Ground-Water Resources of North Dakota," *U. S. Geol. Survey Water-Supply Paper 598* (1929), pp. 103–04.

the North Dakota Geological Survey at Grand Forks. Drillers' logs of the Fargo wells report "green clay" as underlying the Dakota sandstone and overlying granite. Samples show the upper part of the granite to be decomposed to form a soft sticky mass of flaky green kaolinite and quartz grains. This decomposed zone may reach a thickness of 200 feet or more in some places.

Other samples are available from a well drilled at the Soldiers' Home at Lisbon where a drill core at 785 feet consisted of biotite-horn-

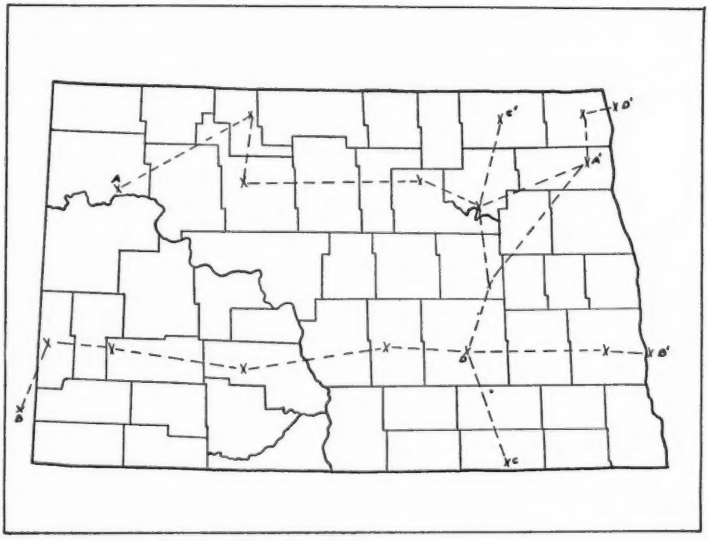


FIG. 1.—Index map of North Dakota, showing locations of sections.

blende granite.[5] A drill-core fragment in the North Dakota Geological Survey offices, labeled as granite from a well drilled at Nome, consists of dark green quartzite.

In addition to samples, a few well logs furnish additional information concerning the pre-Cambrian. A well drilled at Grafton (see log, p. 358) drilled 9 feet of granite. A well at Hamilton (see log, p. 359) drilled 663 feet of "blue granite" and "white sandstone." A well on the University of North Dakota Campus, drilled in 1885, reported red

[4] C. M. Hall and D. E. Willard, "Castleton-Fargo, North Dakota-Minnesota," *U. S. Geol. Survey Geol. Atlas Folio 117* (1905), p. 7.

[5] Howard E. Simpson, *op. cit.*, p. 43.

granite at 425 feet.[6] A well at Glenfield (see log, p. 361) drilled 16 feet of granite gneiss. The Commonwealth Oil and Gas Company's Manitou No. 2 (see log, p. 366), just north of the International Boundary in Manitoba, drilled 24 feet of brown-stained granite. A well at Moorhead, Minnesota, was carried to a depth of 1,901 feet, 1,426 feet into the granite.[7]

In all of those areas such as Fargo and Moorhead where the pre-Cambrian is directly overlain by Cretaceous or younger rocks its surface is altered to kaolinite to considerable depths. In some of the Fargo wells this zone reaches a thickness of 200 feet. The Moorhead well showed a kaolinite zone of 105 feet, but disintegration extended to much greater depths, since artesian flows of water were encountered at 800 feet, at 950 feet, at 1,200 feet, and a small vein of water at 1,700 feet.

Where the pre-Cambrian is overlain by rocks older than the Cretaceous, as at Grafton, Hamilton, and Glenfield (see logs, pp. 358, 359, 361) this kaolinite zone has not been reported, but the fact that the driller carried the Hamilton well to 663 feet in the granite suggests that disintegration was deep enough to make drilling easy to that depth.

The pre-Cambrian surface dips rather steeply west. At Fargo it rises to a height of about 650 feet above sea-level, with a few monadnocks rising even higher. Northward it drops to 100 feet below sea-

[6] Howard E. Simpson, *op. cit.*, p. 138.

[7] *U. S. Geol. Survey Folio 117*, p. 5.

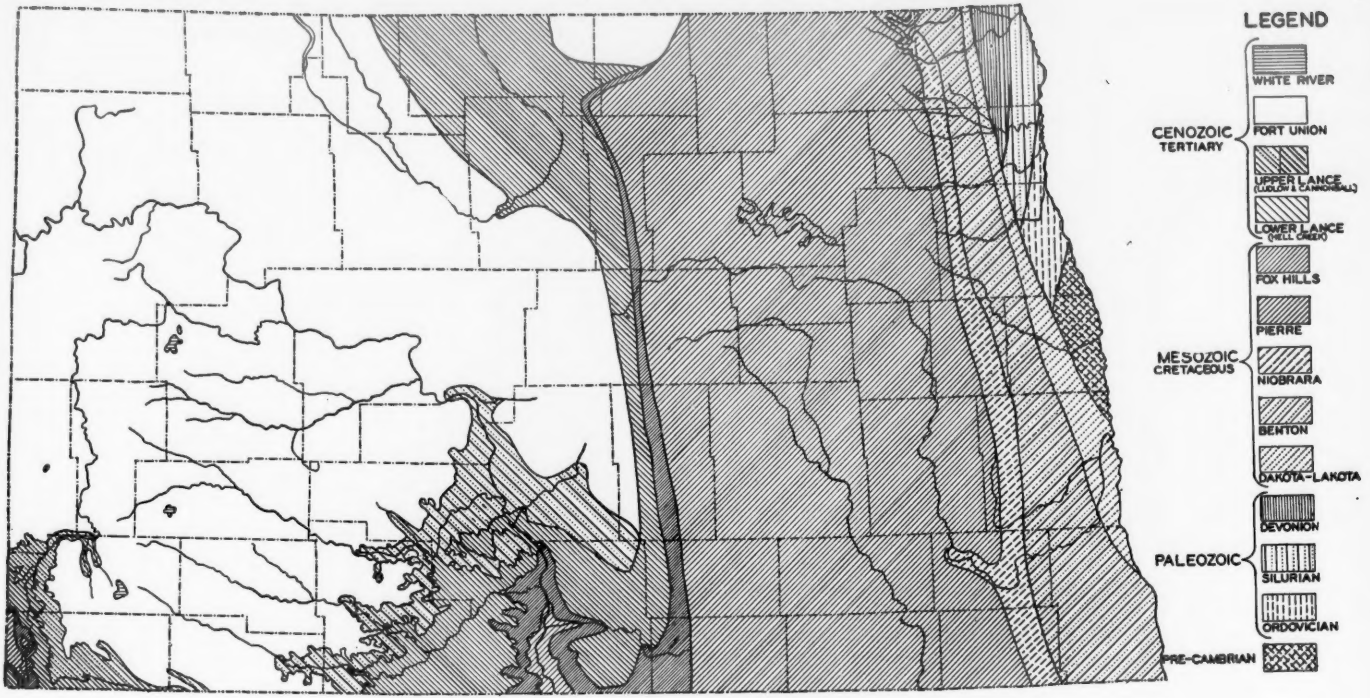
GENERALIZED COLUMNAR SECTION FOR NORTH DAKOTA

			Thickness in Feet	
Cenozoic	Recent	Lake sediments	0–100	Sands and silts of Lakes Agassiz and Souris and Red River Valley deposits
	Pleistocene	Drift	0–500	Glacial boulder-clay
	Tertiary	White River	0–400	Lacustrine and fluvial clay, sandstone and marl
		Fort Union	0–1,300	Light-colored sandstone and clay with much lignite
		Lance	0–800	Ludlow: lignite, brown and gray sandstone, shale, and limestone
				Cannonball: marine sandstone
				Hell Creek: brown to gray sandstone, shale, and limestone

GENERALIZED COLUMNAR SECTION FOR NORTH DAKOTA—*Continued*

			Thickness in Feet	
Mesozoic	Cretaceous	Fox Hills	0–180	Brown to gray loosely cemented and cross-bedded sandstone, ironstone concretions abundant
		Pierre	0–2,600	Gray shale, some sandstone, concretionary beds
		Niobrara	0–280	Limestone, shale, and calcareous shale
		Benton	0–750	Dark gray shale
		Dakota	0–90	Micaceous white sandstone, some gypsum, pyrite, and lignite
		Fuson	0–150	Gray shale, sandy shale, and limestone
		Lakota	0–150	White sandstone, shale, and pyrite
	Jurassic	Morrison	0–185	Variegated shale
		Sundance-Ellis	0–755	Green to gray shale, sandstone, and limestone
	Triassic	Spearfish	0–500	Red shale and sandstone, salt and anhydrite
Paleozoic	Permian	Minnekahta	0–70?	Dolomite, red shale, and anhydrite
		Opeche	0–200?	Red shale
	Pennsylvanian	Minnelusa	0–550	Sandy shale
	Mississippian		0–2,800+	Gray to brown limestone, dolomite, gray and black shale, coal, anhydrite
	Devonian		0–450+	Red to gray shale, cream limestone
	Silurian	Stonewall-Stony Mountain	0–610	Limestone and dolomite
		Red River	0–200	Red shale, limestone, and dolomite
	Ordovician	Winnipeg	0–230	Gray, blue, and reddish brown shale, sandy shale, and sandstone
	Cambrian?	Deadwood?	0–170	Brown micaceous glauconitic sandstone
	Pre-Cambrian			Dark green quartzite, red granite, gneiss

level at Grafton, and westward to 1,765 feet below sea-level at Glenfield. No well west of Glenfield has reached the granite. It is known to



GEOLOGIC MAP OF NORTH DAKOTA

BY

VIRGINIA KLINE

FIG. 2

lie at a depth of considerably more than 8,000 feet in the western part of the state, since The California Company's Kamp No. 1 well (see log, p. 370) near Ray ended in Devonian rocks at a depth of 8,355 feet below sea-level.

In a few places in the Red River Valley erosion has removed Cretaceous rocks which once covered the area so that drift now rests directly on the granite. Several of the Fargo test wells show this condition. In at least one case this can be attributed to the presence of a steep monadnock of granite a short distance west of town. At Grafton and Hamilton (see logs, pp. 358 and 359) rocks of early Paleozoic age overlie the pre-Cambrian. Similar conditions are known to prevail at Glenfield and near Steele (see logs, pp. 359 and 361), and may be inferred to exist at Jamestown, since Devonian rocks have been reported in that area.[8] In the extreme southeastern part of the state the pre-Cambrian is directly overlain by the Dakota or Lakota sandstone of Cretaceous age. In the western part of the southeastern area no wells except those at Nome and Lisbon have gone through the Dakota sandstone, but the writer believes that southeast of a line running approximately from Grand Forks through Valley City and Lisbon the pre-Cambrian is overlain directly by Cretaceous rocks or drift. Deep drilling may, however, disclose local extensions of Paleozoic rocks into this area. West of Glenfield no well in or near the state has reached the granite, so no inferences can be drawn concerning its relationships to overlying beds in the western half of the state escept that it is known to be overlain by rocks of Paleozoic age.

Paleozoic

Cambrian

Four wells in the state, those at Grafton, Hamilton, Glenfield, and near Steele (see logs, pp. 358, 359, 361, and 363), struck a sandstone that is doubtfully assigned to the Cambrian. It overlies the pre-Cambrian and underlies beds of known Ordovician age, but may be of Ordovician rather than Cambrian age.

There are two logs in existence for the Grafton well. The first was turned over to the North Dakota Geological Survey by the mayor of Grafton on completion of the well. This log has been published by Upham[9] and Simpson.[10] This log can not be correlated with the log of the well at Hamilton only a short distance away. The second log differs

[8] Howard E. Simpson, *U. S. Geol. Survey Water-Supply Paper 598*, p. 232.

[9] Warren Upham, *U. S. Geol. Survey Mon. 25*, p. 77.

[10] Howard E. Simpson, *op. cit.*, p. 246.

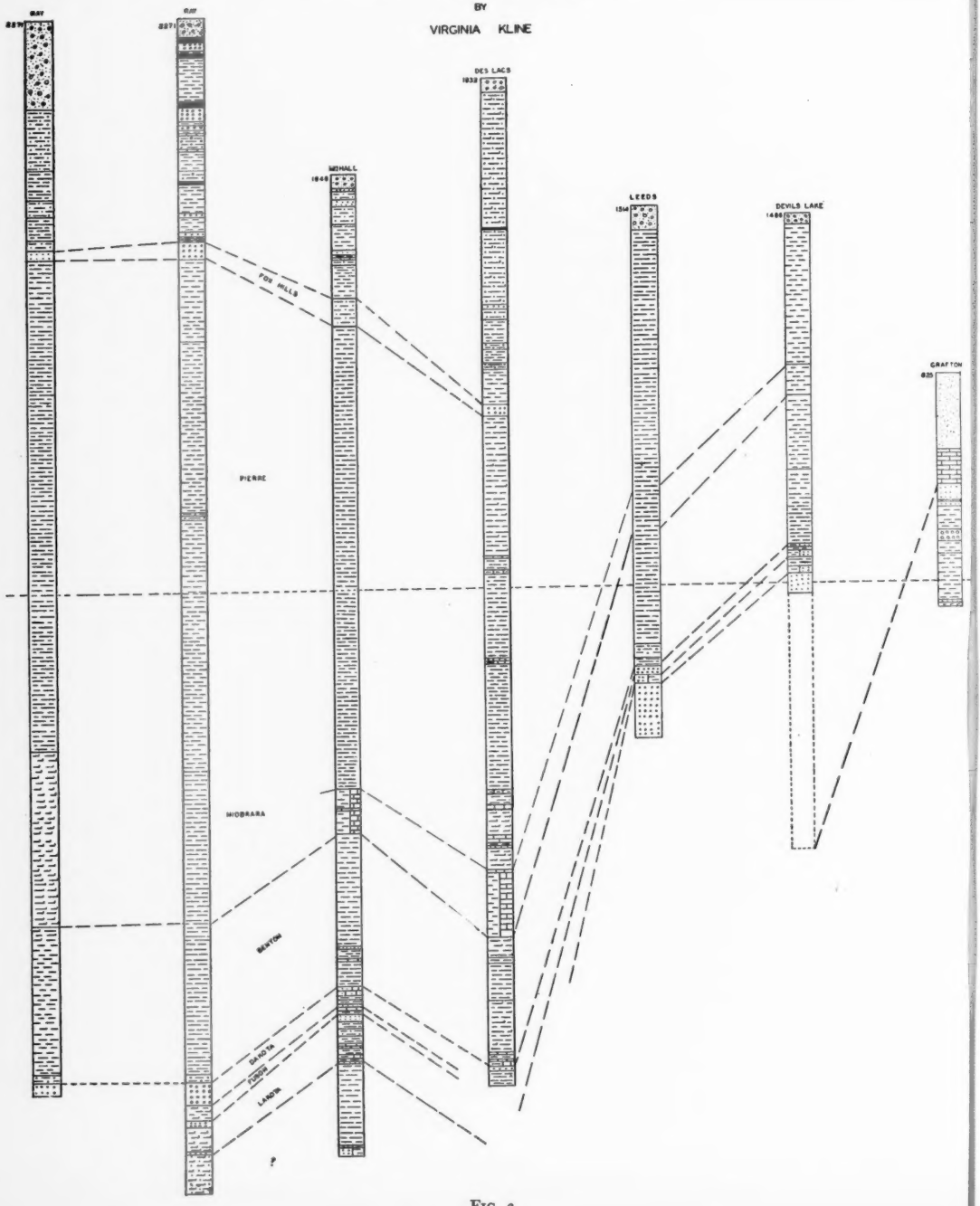
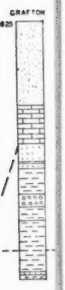

SECTION ALONG LINE A-A'
BY
VIRGINIA KLINE
DES LACS
1938
LEEDS
1514
DEVILS LAKE
1488
GRAFTON
835
PIERRE
NIOBRARA
BENTON
DAKOTA
LANSING
?

FIG. 3

completely from the first, even to a slight difference in total depth. This log was made by the drilling company and was not turned over to the Survey until approximately 20 years after completion of the well. Simpson[11] also published this log. This second log is accepted by the writer as being more probably correct and is used in this paper.

The Grafton well shows 3 feet of white sand overlying the pre-Cambrian, and the Hamilton well 5 feet of white sand in the same interval.

Reeside's log of the Glenfield well (see log, p. 359), based on samples, shows the basal Paleozoic strata to consist of 155 feet of dark brown micaceous glauconitic sandstone with a 15-foot bed of red and gray shale near the middle.



The log of the Prairie Oil and Gas Company well near Steele (see p. 361) shows the well as bottomed in 65 feet of dark sand and sandy shale. The pre-Cambrian was not reached.

According to Hume,[12] there is no evidence that Cambrian rocks ever were present in Manitoba. They are known to be absent in the Fargo area, but thicken rapidly westward from 3 feet at Grafton to 170 feet at Glenfield. Therefore, this sandstone has been tentatively correlated with the Deadwood formation. Any such correlation, however, must be considered as a suggested possibility rather than as a certainty until more information is available.

ORDOVICIAN-SILURIAN

Knowledge of both Ordovician and Silurian rocks in the state is also confined to the wells at Grafton, Hamilton, Glenfield, and Steele (see logs, pp. 358, 359, and 361). Since these strata are best correlated with wells in Manitoba and with outcrops in the Winnepeg area, Canadian formation names have been used.

The Ordovician in Manitoba consists, in ascending order, of the Winnipeg sandstone, the Red River formation, and the Stony Mountain, and the Silurian of one formation, the Stonewall limestone.

The Winnipeg sandstone has been described by Dowling[13] and later by Hume[14] and others from outcrops on islands in Lake Winnipeg and along its shores and also from wells in Manitoba. The Winnipeg sandstone in Manitoba is described as consisting of green shales and white sandstone reaching a maximum thickness of more than 100 feet. In the

[11] *Ibid.*, p. 247.

[12] G. S. Hume, *Canada Geol. Survey Econ. Ser. 5*, pp. 41, 257.

[13] D. B. Dowling, *Canada Geol. Survey Ann. Rept.*, Vol. XI.

[14] G. S. Hume, *op. cit.*, pp. 41, 256–58.

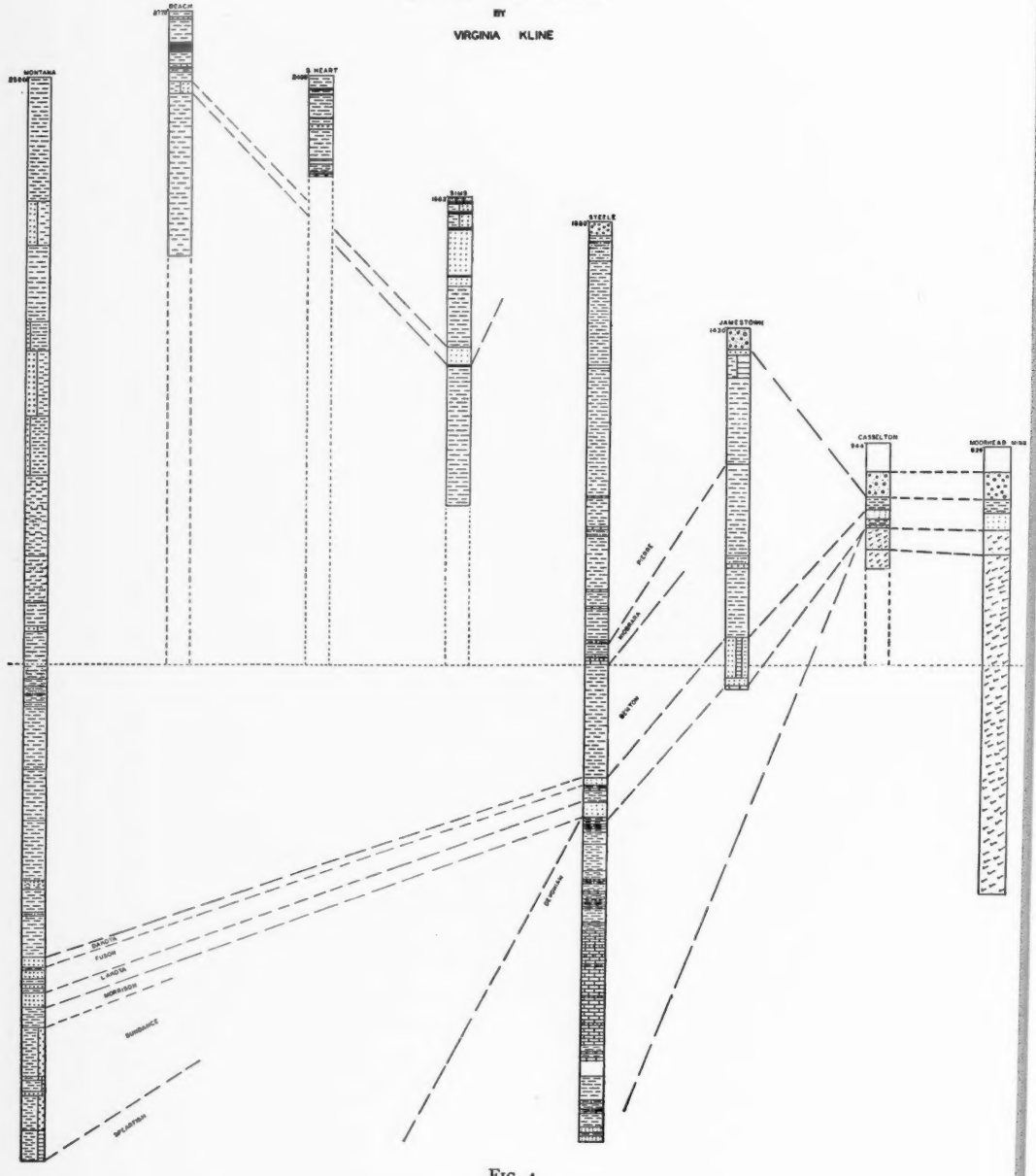

SECTION ALONG LINE B-B'
BY
VIRGINIA KLINE
MONTANA
BEACH
S. HEART
STEELE
JAMESTOWN
CASSELTON
MOORHEAD
PIERRE
NIOBRARA
BENTON
FUSON
LAKOTA
MORRISON
SUNDANCE
SPEARFISH

FIG. 4

Commonwealth Oil and Gas Company's Manitou well No. 2 (see p. 366) in Manitoba the Winnipeg sandstone consists of 123 feet of dull green shale with a 2-foot bed of sand near the base. The age of the Winnipeg sandstone is considered to be Black River or younger.

Four wells in North Dakota reached strata which have been assigned to the Winnipeg sandstone. At Grafton (see p. 358) 135 feet of green or gray shale and 20 feet of red shale have been placed in this formation. At Hamilton (see p. 359) the formation consists of 130 feet of blue shale. At Glenfield (see p. 361) it includes 230 feet of blue gray and reddish brown shale. At Steele (see p. 363) it includes 214 feet of shales and sandy shales.

The overlying Red River formation has been described by Hume,[15] Wickenden,[16] and others from exposures on islands in Lake Winnipeg. It has been divided in Manitoba into, in ascending order, the Dog Head limestone, the Cat Head limestone, and the Selkirk limestone. Foerste[17] has identified the formation as of Richmond age. It is correlated by Hume with the Whitewood formation of the Black Hills and the Big Horn limestone of Wyoming and Montana, indicating that it underlies most of North Dakota. In outcrop the Red River formation consists of limestones and cherty limestones. In the Manitou well No. 2 (see p. 365) it consists of 473 feet of light-colored dolomites, limestones, and calcareous muds.

The Red River formation can be distinguished in only three wells in North Dakota, although it is probable that some of the limestones in the Hamilton well listed as Stony Mountain-Stonewall (see p. 359) should be placed in the Red River formation. Somewhat the same condition prevails at Grafton, where only 45 feet of red shale and limestone have been placed in the Red River formation (see p. 358). At Steele (see p. 363) 138 feet of limestone, shale, and sandstone have been correlated with the Red River formation. At Glenfield (see p. 361) Reeside has logged 200 feet of dolomite, shale, and limestone which have been placed in the Red River formation.

The Stony Mountain formation has been described by Dowling,[18] Hume,[19] Wickenden,[20] Kindle,[21] and others from Stony Mountain in

[15] G. S. Hume, *op. cit.*, pp. 41–43, 256–58.

[16] R. T. D. Wickenden, *Canada Geol. Survey Summ. Rept.* (1933), Part B, p. 159B.

[17] A. F. Foerste, *Univ. Michigan Mus. Pal.*, Vol. 3, No. 3.

[18] D. B. Dowling, *op. cit.*

[19] G. S. Hume, *op. cit.*

[20] R. T. D. Wickenden, *op. cit.*

[21] E. M. Kindle, *Canada Geol. Survey Summ. Rept.* (1912), p. 249.

SECTION ALONG LINE C-C'

BY

VIRGINIA KLINE

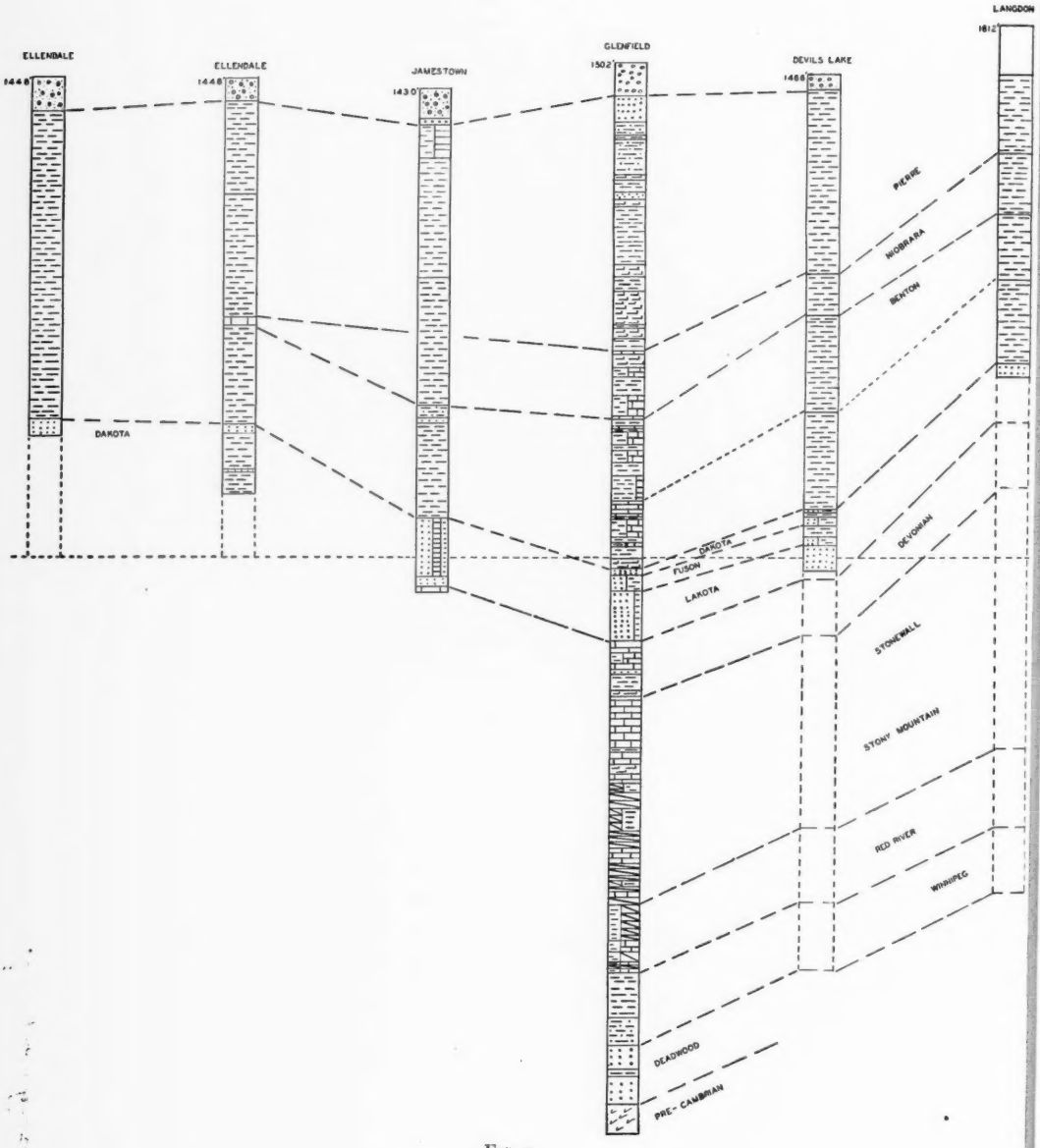


FIG. 5

Manitoba. In outcrop it consists of dark buff limestones, but in well logs includes shales and dolomite. It is of Richmond age.

The name Stonewall was proposed by Kindle[22] to include all Silurian beds on Lakes Manitoba and Winnipegosis, the name being taken from the town of Stonewall. The Stonewall formation is made up primarily of dolomitic limestones and limestones, with local gypsum beds. According to Kindle, it is much lighter in color than the overlying Stony Mountain formation where the two are found in outcrop. It is identified as late Middle Silurian in age.

At present it is impossible to make any separation of the Stony Mountain and Stonewall formations in North Dakota. There is no sharp distinction in lithology between the two formations as described from outcrop, and none of the North Dakota wells shows a break sharp enough to be identified with certainty as the break between the formations. The log of the Manitou well No. 2 (see p. 365) shows 117 feet of dolomite, with a very little limestone, sand, and sandy dolomite of Stony Mountain age overlain by 410 feet of dolomite and limestone, predominantly pink in color, belonging to the Stonewall formation.

At Grafton (see p. 358) 337 feet of limestone with a little red shale has been assigned to the Stony Mountain-Stonewall. At Hamilton (see p. 359) the same interval is occupied by 474 feet of limestone with a little shale. The basal portion of this limestone may be of Red River age. At Glenfield (see p. 360) Reeside's log shows 620 feet of dolomite, limestone, and shale, including many beds which are pink in color, which have been assigned to the Stony Mountain-Stonewall formations. At Steele (see p. 363) these formations consist of 478 feet of limestone, sandy limestone, and sandstone.

DEVONIAN

Devonian strata are the youngest Paleozoic rocks in the state not overlapped by Cretaceous sediments. They immediately underlie drift and lake sediments in the northeastern corner of the state.

A well drilled at Morden, Manitoba (see p. 366), not far north of the International Boundary, ended in 188 feet of shale with a little limestone. The color is predominantly red or gray. The wells at Hamilton and Grafton (see pp. 358 and 359) encountered Devonian rocks immediately underlying the drift. The former drilled 99 feet of red and blue shales of Devonian age, and the latter 138 feet of red and blue shales and white sandstone. At Glenfield (see p. 360) Reeside's log shows 100 feet of light-colored limestone and shale overlying 70 feet of predominantly red shale. The section at Steele (see p. 362) consists of

[22] E. M. Kindle, *op. cit.*

SECTION ALONG LINE D-D'

BY

VIRGINIA KLINE

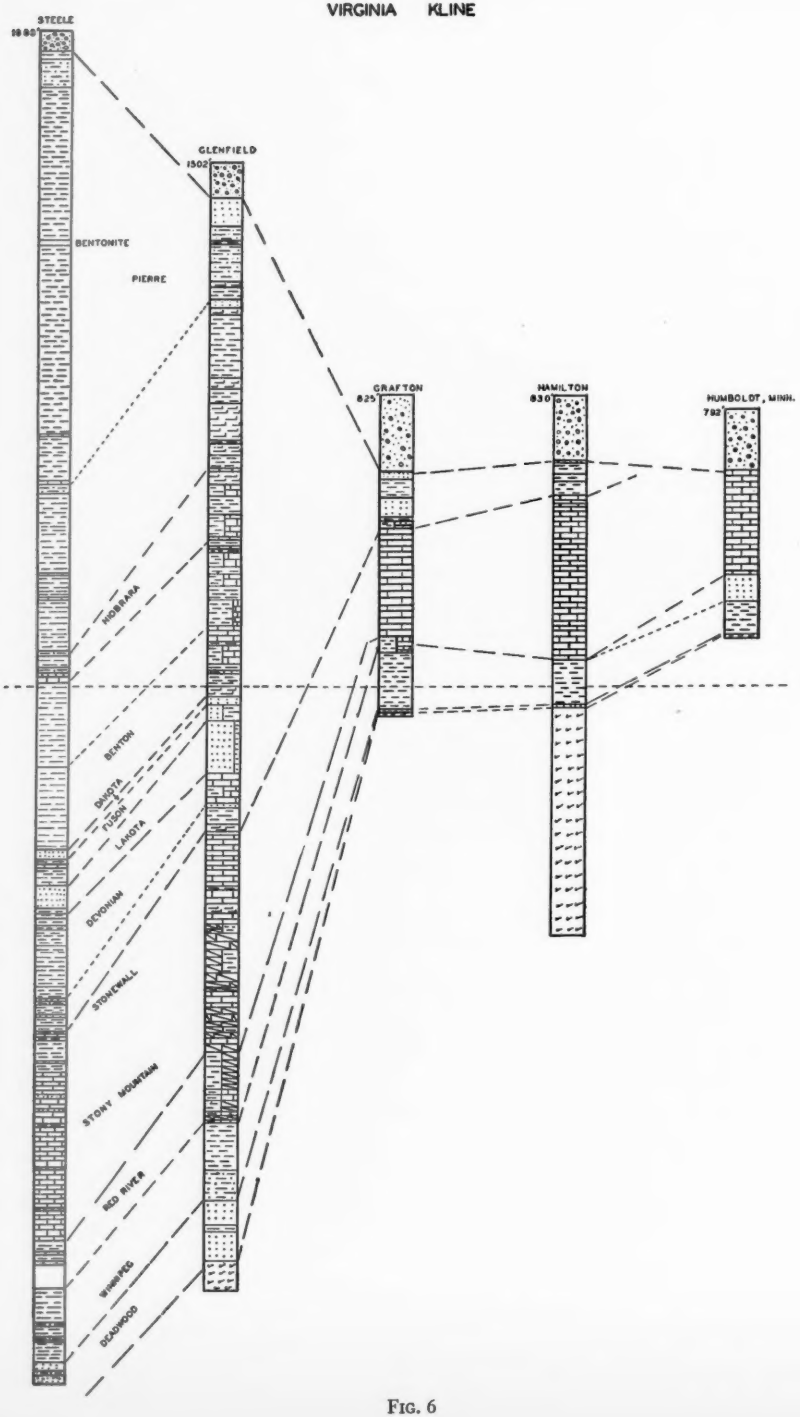


FIG. 6

454 feet of red and blue shale with a little sandstone and limestone, the upper part of which may be of post-Devonian age.

The Kamp well No. 1 is believed to be bottomed in Devonian strata, but the top of the Devonian (?) in this well can not be determined with any degree of certainty.

It is highly probable that Devonian rocks underlie all of North Dakota except part of the Red River Valley and the southeastern corner of the state. No formation name can be applied to these rocks until their relationships are better known.

MISSISSIPPIAN

Mississippian strata have been recognized in only one well in the state, the Kamp No. 1 (see p. 370), where they reach a minimum thickness of at least 2,800 feet. They are absent at Glenfield.

The Mississippian section in the Kamp No. 1 is characterized by black and gray shales and coal in the upper part, red shale and salt in the middle, and limestones and dolomites at the base, with scattered anhydrite throughout.

PENNSYLVANIAN-PERMIAN

The Pennsylvanian and Permian are also known only from the Kamp No. 1 where they reach a combined thickness of about 650 feet. Formation breaks have not been established with complete certainty.

This section consists for the most part of red shales and purple sand and sandy shale.

MESOZOIC

TRIASSIC

About 500 feet of red shale, sandstone, salt, and anhydrite make up the Spearfish redbeds. This formation is composed largely of red shales with considerable gray and black shale and minor amounts of red sand and limestone.

JURASSIC

The Sundance consists of green to gray shale with some sandstone in the upper part and limestone in the lower. It has a thickness of 755 feet in the Kamp No. 1 (see p. 371). A well drilled at Mohall (see p. 369) bottomed in the Sundance.

The Morrison in the Kamp No. 1 is made up of 185 feet of green and gray shale with some pink and gray shale. At Mohall it reaches a thickness of about 100 feet.

CRETACEOUS

With the exception of the northern part of the Red River Valley and isolated monadnocks on the south, all of North Dakota is known to be underlain by Cretaceous rocks which immediately underlie drift in an area comprising at least half of the state. In addition to a limited number of exposures, many records are available of wells drilled into or through the Cretaceous sediments. The Cretaceous is the oldest period about which much is known in the state.

LAKOTA

Although the possibility of the Fuson and Lakota being present in the state has long been recognized, the general term "Dakota" has usually been applied in the state to all sandstones and interbedded shales at the base of the Cretaceous. Few drillers keep accurate logs after reaching the Dakota, so it is impossible to map these three formations separately, but all are known to be present in at least the eastern half of the state.

The Lakota consists of white sandstone with a little shale. Samples from wells at Devils Lake and Langdon show abundant pyrite. It varies in thickness from 78 to 150 feet. Most logs of "Dakota" wells[23] show two flows and many show three, the first and second being separated by a fairly thick shale break. In some wells the second and third flows are separated by a thin shale break, and in others the entire section is sandstone, the break being caused by a decrease in porosity. It seems reasonable to assume that wells deriving their water supply from the second and third flows are actually Lakota rather than Dakota wells.

FUSON

The Fuson has long been noted as a shale break between flows. Its thickness and lithology vary greatly throughout the state. In general it consists of gray shale and thin beds of sandy shale, sandstone, and limestone. These beds appear to be lenticular, since wells a short distance apart may show entirely different sections. This discrepancy may, however, be due in part to inaccuracies in drillers' logs, since most drillers are interested only in water horizons. The thickness of the Fuson appears to have an indirect ratio to that of the Lakota, the two having a combined thickness of about 200 feet.

Samples of some of the Fargo wells show the Cretaceous to consist of a thin bed of blue shale overlying a thin bed of sand, which in turn rests on the pre-Cambrian. It appears most probable that this shale

[23] For additional logs see Howard E. Simpson, *U. S. Geol. Survey Water-Supply Paper 598.*

is Fuson rather than Benton, and that the easternmost extension of the true Dakota sandstone is on the west.

DAKOTA

The Dakota sandstone in the properly restricted sense is a thin bed of micaceous white sandstone with associated pyrite, gypsum, and lignite. It is somewhat thinner than the Lakota, ranging from 15 to 90 feet in thickness. The sand varies from medium- to coarse-grained, is loosely cemented, and for the most part composed of quartz. The writer found a few Foraminifera of species common to the Benton in samples of the upper part of the Dakota from a well drilled at Devils Lake. They may have been carried down in drilling, since they are very rare and are limited to Benton species.

In water wells drilled in the eastern half of the state the first flow, which comes from the Dakota sandstone, is soft water with low iron and high chloride content, as opposed to the Lakota flows with high iron and low chloride content.[24]

In the western part of the state the Lakota, Fuson, and Dakota seem to grade into a series of alternating thin beds of sandstone, shale, and sandy shale which do not show any sharp breaks. Much more careful observation by drillers of beds below the base of the Benton will be necessary in order to separate and delimit completely these three formations.

BENTON

The Benton is the oldest formation known to be exposed in the state. The Pembina and Little Pembina rivers have cut deeply through the drift and overlying Cretaceous sediments to expose the Benton at their junction and for some distance upstream. Along the Pembina River it probably crops out to the Canadian border but is concealed by heavy vegetation for the last few miles. No outcrops could be found in that area except one section of basal Pierre beds about 250 feet above river level. At the Mayo Brick Plant, near the junction of the two rivers, is found the best known exposure of the Benton in the state. The section consists of about 150 feet of soft plastic black clay which drys to a hard dark bluish clay. It stands in rather steep slopes, the surfaces of which are covered with large selenite crystals, in some places in masses several inches long. Abundant free sulphur is also present. Black shales at the base of the Pierre strongly resemble the Benton but do not contain such large numbers of selenite crystals.

As determined from well logs the Benton consists of gray non-calcareous shales with an average thickness of 500–600 feet. A few

[24] G. A. Abbott and F. W. Voedisch, *North Dakota Geol. Survey Bull. 11*, p. 37.

thin lenses of sandstone, limestone, and sandy or calcareous shale have been noted. Complete samples were kept of the Benton in wells at Langdon, Devils Lake, Des Lacs, and Glenfield. Microfossils are present throughout, including the species: *Lenticulina* sp., *Gümbelina globosa* (Ehrenberg), *Globigerina cretacea* d'Orbigny, and other less common forms. In the Devils Lake and Langdon samples about 95 per cent of the shells belong to the species *G. cretacea* d'Orbigny. These samples show an abrupt increase in number of shells at 255 and 280 feet, respectively, above the top of the Dakota sandstone. This zone appears to be about 175–200 feet thick. Below it the fauna is again sparse. Reeside reports a corresponding zone of fossils at Glenfield (see p. 360) in a limestone 200 feet above the Dakota sandstone. This limestone, with a few shale breaks, is about 140 feet thick. Reeside shows a calcareous shale occupying this same interval in the Des Lacs well (see p. 367), but he does not report any fossils as being present in samples from this interval. This break is also shown in some well logs, as at Steele (see p. 362), where the driller noted a change from dark gray to light gray shale at 245 feet above the Dakota. Samples from the Kamp well No. 1 show microfossils throughout, but no sharply marked break.

The Benton of eastern North Dakota falls rather easily into three distinct subdivisions: a lower, dark gray, non-calcareous, only slightly fossiliferous shale; a middle, light gray, highly fossiliferous limestone or calcareous shale; and an upper, dark gray, non-calcareous, only slightly fossiliferous shale. Only this upper division has been seen in any of the exposures in the state. This tripartite division suggests a possible correlation with the Carlile, Greenhorn, and Graneros formations into which the Benton has been divided in South Dakota and Wyoming. According to most available records, no sharp lithologic break is present, but the division can be made in the eastern part of the state, especially if the fossil zone is well defined.

NIOBRARA

The Niobrara is known to be exposed in two areas in the state: along the Pembina and Little Pembina rivers, and along the Sheyenne River near Fort Ransom. A soft, light-colored, calcareous shale cropping out at Valley City is believed to belong in the Pierre rather than in the Niobrara, in which formation it has previously been placed. Only a very great thickness of the Niobrara could cause that formation to crop out in that area.

In the Pembina Mountains the Niobrara consists of "cement rock," a hard, gray, rather argillaceous limestone containing abundant Fora-

minifera, and of light-colored shales which are only slightly calcareous and become plastic on weathering. Contact between the Niobrara and Pierre, where observed, is ordinarily marked by a thin bed of limonite, and the Niobrara is deeply stained with limonite to a depth of 20 or 30 feet in some places. Near the Mayo Brick Plant, where the Niobrara crops out, it reaches a thickness of at least 165 feet.

Where exposed in the valley of the Sheyenne River below Fort Ransom the Niobrara is made up of massive beds of reddish and yellowish chalk with thin seams ($\frac{1}{2}$ inch or more) of fullers earth. Several small faults with displacements of 3 or 4 inches were noted.

As determined from well samples and logs, the Niobrara varies greatly in lithology and thickness throughout the state. The thickness ranges from an average of about 200 feet in the eastern part of the state to 267 feet at Des Lacs (see p. 367) and 160 feet in the Kamp No. 1 (see p. 371). In composition it includes limestone, chalk, calcareous and non-calcareous shales, and even sandstone. Samples from the Langdon and Devils Lakes wells showed a slightly calcareous dark gray shale containing such large numbers of Foraminifera as to have caused it to be considered a limestone at first. The Foraminifera belong to the same species as those found in the Benton, with the addition of the species: *Planulina kansasensis* Morrow, *Planulina complanata* (Reuss), and *Gyroidina nitida* (Reuss). *Globigerina cretacea* d'Orbigny was relatively less common in the Niobrara samples studied than in the Benton. In the Kamp well No. 1 the Niobrara can easily be recognized by the presence of large numbers of microfossils. At Glenfield and Des Lacs the Niobrara consists of limestone, shale, and calcareous shale (see pp. 360 and 367). Drillers' logs commonly report about 200 feet of light gray shale overlain and underlain by black shale in the interval where the Niobrara should occur. This makes the Niobrara the most difficult of the Cretaceous formations to recognize. Where samples and fossils are lacking, the Niobrara can best be identified as any light gray shale or limestone which lies between the black shales marking the base of the Pierre and similar black shales at the top of the Benton.

PIERRE

The Pierre underlies the drift in most of the eastern half of the state, except in the Red River Valley, and also crops out along the Missouri River in the south-central part of the state and along the Little Missouri in the southwestern corner. Exposures are fairly common in the two latter areas as well as along the James and Sheyenne rivers and in the Pembina Mountains.

The lowermost beds of the Pierre are exposed at numerous locali-

ties between Mountain and the point where the Pembina River crosses the International Boundary. A typical section of the lower Pierre in the cuts at the McCloud mine 3 miles west of Mountain follows.

	Thickness	
	Feet	*Inches*
Drift		
Black shale with abundant fibrous satinspar crystals	50	
Black shale with fullers earth partings	8	
Fullers earth		1
Black shale	1	3
Fullers earth		3
Black shale with thin partings of fullers earth	1	8
Fullers earth		7
Black shale		4
Fullers earth		8
Black shale		2
Fullers earth		3
Black shale		2
Fullers earth		3
Black shale		2
Fullers earth		3
Black shale with two ½-inch seams of fullers earth		8
Fullers earth		6
Black shale		6
Fullers earth		4
Black shale		2
Fullers earth		5
Black shale		9
Fullers earth		3
Black shale with fullers earth partings	1	
Fullers earth		3
Black shale		3
Fullers earth		3
Black shale		7
Fullers earth		1.5
Black shale		4
Fullers earth		3
Black shale		4
Niobrara		
Limonitic shale	2	
"Cement rock"	15 exposed	

The black shale associated with the fullers earth weathers to soft plastic clay resembling the Benton, from which it differs in possessing abundant fish scales but no Foraminifera and fewer selenite crystals. The skeleton of a mosasaur, nearly complete except for the head, was taken from these beds near Mountain in the spring of 1937, and is now in the North Dakota Geological Survey Collections. Isolated vertebrae were picked up by the writer at three other localities within a radius of a few miles, all of them in beds associated with fullers earth.

The beds of fullers earth thin northwest and become faulted and lenticular. They appear to be local in distribution since none was found south of Mountain and none was recognized in samples from the well at Langdon, about 15 miles west. In well samples this basal Pierre

has been seen only as black shale, in the upper part of which satinspar crystals are in places very common.

Beds higher in the Pierre can not be subdivided without considerable more study. On the whole, the Pierre is composed of gray shales which weather into thin hard flakes rather than breaking down into a clay. Numerous thin zones of ironstone concretions are present. One 25-foot bed of sand was noted in several wells about 500 feet above the top of the Niobrara. Numerous thin beds of limestone and sandy shale are reported in well logs, but all appear to be more or less local. The calcareous shale outcropping at Valley City is an example of one such bed which may be equivalent to the chalk in the upper Gregory of South Dakota.

The known thickness of the Pierre ranges from 930 feet near Burnstad to 2,390 feet in the Kamp No. 1.

FOX HILLS

The Fox Hills sandstone crops out in three areas in the state: in a north-south band paralleling the western edge of the Pierre, along the Missouri River in the south-central part of the state, and along the Little Missouri River in the southwest corner. The Fox Hills is a very thin formation, with a correspondingly small area of outcrop. The section is best shown west of the Missouri in the area which was not visited, but a few scattered outcrops are to be found between Burnstad and Wishek and directly east. Others were noted along Horsehead Lake and west of Sibley Lake.

The Fox Hills consists of brown to gray loosely consolidated sandstone which displays much cross-bedding. Ironstone concretions are common in thin bands. Locally, this formation may consist of sandy shales or may be entirely absent.

This formation as noted in well logs varies in thickness from 40 to 180 feet in those areas where it can be recognized. It is very similar to sandstones in the Lance and Fort Union formations, and can be determined with certainty only where fossils are present or where its position with reference to the Pierre is known.

CENOZOIC

TERTIARY

LANCE

The Lance formation falls rather readily into three members: the Hell Creek of lower Lance age and the Ludlow and Cannonball of the upper Lance.[25]

[25] For more detailed descriptions of Tertiary formations see North Dakota Geological Survey bulletins by A. G. Leonard.

The Hell Creek member has the largest area of outcrop, being exposed along the Souris River, the Missouri River, and the Little Missouri. It is continental in origin and contains dinosaur remains. Lithologically the Hell Creek consists of about 500 feet of sandstone, sandy shale, shale, and limestone. Rare beds of gravel and lignite are also present. The rocks in general are brown or gray in color and have been called the "somber" beds. A striking feature of this formation is peculiarly shaped sandstone concretions, some of which resemble logs and others of which are in the form of huge disks, 3 or 4 inches thick and several feet in diameter. Such concretions have been reported west of the Missouri and were seen along the Souris River near Verendrye and between Wishek and Linton. Ironstone concretions are also common. Sandstone members are for the most part more firmly cemented than those in the Fox Hills and display marked cross-bedding.

The upper Lance in the southwestern part of the state is known as the Ludlow member. This reaches a thickness of about 250 feet and resembles the Hell Creek member except that it carries numerous beds of lignite.

The Cannonball, which is equivalent in age to the Ludlow, marks a brief return of marine conditions in the south-central part of the state. During this time 300 feet of massive sandstone and interbedded sandstone and shale containing marine fossils were deposited. In addition to the outcrops of Cannonball shown on the map, it is possible that some of the Lance beds along the Souris River should be placed in that formation, but most of the outcrops seen were distinctly of lower Lance age, and none contained fossils to afford proof of Cannonball age.

FORT UNION

The Fort Union forms the bedrock surface in a larger part of the state than any other formation except the Pierre. At present it is confined to the western half of the state and to the Turtle Mountains, but the Turtle Mountain outlier suggests a much wider areal distribution at some earlier date.

In the Marmarth district the Fort Union has been divided into two members, the upper one of which has largely been removed by erosion. The lower Fort Union consists of 700–800 feet of white clay, sandy clay, and sandstone of fresh-water origin. Numerous thick beds of lignite are present. In some areas thin beds of limestone have been noted near the base of the section. High in the lower Fort Union burning of lignite beds has caused the formation of a conspicuous red "scoria" or clinker. This clinker marks approximtely the division between the upper and the lower Fort Union. This formation differs in general from

the Lance in having thicker beds of lignite and more sandstone, which is finer-grained and shows less cross-bedding.

Above the "scoria" in some localities are 450–500 feet of shale and sandstone which bear a strong resemblance to the Lance beds.

WHITE RIVER

Only four isolated areas of White River beds are known in the state: Kildeer Mountains, White Buttes, Sentinel Butte, and the Little Bad Lands. Buttes in these areas made up of Fort Union beds are capped with clays, sandstones, and marls of lacustrine and fluvial origin. These beds reach a maximum thickness of 400 feet and contain remains of primitive vertebrates.

PLEISTOCENE

Most of the bedrock formations are overlain by a thick mantle of drift. Only in the southwest corner of the state is drift lacking. In other areas rivers have cut through the drift to expose the underlying beds.

Deposits of pre-Wisconsin age and two stages of the Wisconsin are known. Pre-Wisconsin drift is known in the northwest corner of the state and southwest of the Missouri. It consists of gravel and boulders with little or no clay. The Wisconsin drift, on the contrary, is typical boulder-clay, consisting for the most part of clay although only outwash sands and gravels are present in some areas. The drift reaches a maximum thickness of 400–500 feet in the state, but is less than 100 feet thick in most localities.

RECENT

Overlying the drift in the Red River Valley and in the valley of the Souris River are sands and silts which were deposited in Lakes Agassiz and Souris. Sands in the bed of Lake Souris average about 60 feet in thickness. Lake Agassiz silts have a known maximum thickness of about 100 feet.

SUMMARY

The geologic history of North Dakota has been complex, obscured by considerable erosion and by glaciation. Cretaceous and Tertiary formations are comparatively undisturbed and lack major unconformities. With the exception of the Dakota, Fuson, and Lakota formations, all may be seen in outcrop. Knowledge of pre-Cretaceous rocks is very limited and derived entirely from a few well logs and a few samples.

The Cretaceous beds have a regional dip of about 10 feet per mile west. The pre-Cambrian surface slopes west at a rate of at least 25 feet per mile. At the base of the Cretaceous is an unconformity which increases in magnitude from the western part of the state, where the Jurassic is present, to the Red River Valley where the Cretaceous rests on middle Paleozoic to pre-Cambrian rocks. The difference in dip of Cretaceous beds and the pre-Cambrian surface has allowed the accumulation of at least 7,000 feet of sediments in the western part of the state, which were either never deposited or have been removed in the eastern part. No wells have been drilled in the central part which might give a clue to the easterly extension of the Mississippian to Jurassic formations.

Well logs which give typical sections of the various formations present in the state follow.

GRAFTON, WALSH COUNTY
Sec. 13, T. 157, R. 53
(*U. S. Geol. Survey Water-Supply Paper 598*, p. 247)

	Depth in Feet
Surface	3
Recent	
Lake deposits	
Yellow clay	13
Blue clay	103
Pleistocene	
Drift	
Gravelly clay	133
Quicksand	155
Hard pan	195
Sand and gravel	225
Devonian	
Sand	245
Red shale	265
Limerock	267
Red shale	297
White sandrock	357
Blue shale	360
Red shale	363
Silurian-Ordovician	
Stonewall-Stony Mountain	
Limerock	367
Red shale and lime	390
Limerock	700
Red River	
Red shale and lime	745
Winnipeg	
Gray slate	785
Greenish blue shale	880
Dark red shale, gritty	900
Cambrian (?)	
Deadwood (?)	
White sandrock	903
Pre-Cambrian	
Gray granite	912 T. D.

HAMILTON, PEMBINA COUNTY

Sec. 35, T. 162, R. 53

(*U. S. Geol. Survey Water-Supply Paper 598*, p. 184)

Surface	10	
Recent		
Lake deposits		
Blue clay	132	
Coarse sand, surface water	174	
Pleistocene		
Drift		
Hard pan, cemented gravel	189	
Devonian		
Quicksand	193	
Red shale	225	
Blue shale	245	
Red shale	288	
Silurian-Ordovician		
Stonewall-Stony Mountain		
Gray limestone	300	
Blue shale, main flow saline	307	
Gray limestone	584	
Pink limestone	609	
Gray limestone	762	
Winnipeg		
Blue shale, caving	892	
Cambrian (?)		
Deadwood (?)		
White standstone	897	
Pre-Cambrian		
Blue granite	1,241	
White sand	1,241½	
Blue granite	1,244	
White sandstone	1,560	T. D.

GLENFIELD, FOSTER COUNTY

SE. ¼ Sec. 8, T. 146 N., R. 62 W.

(Log by J. B. Reeside, Jr., from samples, *U. S. Dept. Interior Press Release*)

Pleistocene	
Drift, clay and boulders	97
Water, sand, water associated with lignite	187
Cretaceous	
Pierre	
Light gray sandy shale	220
Light gray hard shale with *Inoceramus* prisms	230
Light gray sandy shale: *Inoceramus* prisms throughout upper part	340
Light gray hard limy shale	360
Light gray softer shale	390
Medium-grained quartz sand	420
Light gray hard limy shale	440
Light gray softer shale, *Inoceramus* prisms present in lower part	490
Dark gray shale	500
Light gray hard shale with *Inoceramus* prisms	530
Very dark soft shale, with *Inoceramus* prisms and fragments of invertebrate shells	550
Very dark hard shale, with *Inoceramus* prisms	580
Medium gray shale; middle third very limy	690
Light gray fairly hard shale, very limy	790
Light gray soft shale	800
Light gray fairly hard shale, very limy	840

Medium gray soft shale	860
No cuttings; driller says "hard shale"	880
Niobrara	
Light gray limestone	890
Medium to dark gray limy shale	920
Medium gray shale and limestone	960
Medium gray soft shale	1,010
Medium gray shale and limestone	1,040
Medium gray soft shale and limestone with *Inoceramus* prisms	1,070
Light gray limestone	1,080
Benton	
Very dark gray soft shale with *Inoceramus* prisms	1,100
Light gray limestone	1,110
Dark gray soft shale	1,120
Medium gray shale and limestone	1,160
Dark gray soft shale	1,190
Dark gray limestone and shale	1,210
Dark gray soft shale	1,240
Nearly black flaky shale	1,260
Medium and darker gray shale with a little limestone; fragments of *Ostrea, Inoceramus*	1,330
Medium gray limestone with *Inoceramus, Ostrea, Globigerina,* and a shark tooth	1,370
Bluish gray soft shale	1,380
Brownish gray limestone and shale, with *Inoceramus* and *Ostrea*	1,400
Light gray limestone and shale with *Inoceramus*	1,420
Medium gray shale and limestone	1,430
Light gray hard shale	1,440
Dark gray hard shale	1,460
Medium gray shale and limestone	1,470
Dark soft shale	1,480
Light gray shale	1,490
Dark gray soft shale	1,500
Light gray limy shale	1,530
Dakota	
Fine quartz sand	1,540
No cuttings; red shale according to driller	1,548
Coarse quartz sand, grains 2 mm. or less	1,551
Fuson	
Cuttings coarse sand and bluish gray shale	1,600
Lakota	
Coarse quartz sand in part coated with iron oxide; some shale mixed with sand	1,610
Coarse quartz sand, grains to 3 mm. diameter	1,620
Mixture of coarse and fine sand and shale	1,640
Fine gray sand, chiefly quartz and mixed with some soft shale	1,730
Sand and gray shale chips	1,750
Devonian (Formation tops picked by Reeside only through Dakota)	
Light-colored limestone	1,790
Gray shale and limestone	1,820
Light-colored limestone	1,835
Fine light-colored quartz sand	1,850
Red shale, flaky, hard non-calcareous	1,860
Light blue-green shale, no lime	1,870
Red shale, no lime	1,900
Red limy shale	1,910
Gray-white limy shale	1,920
Silurian-Ordovician	
Stonewall-Stony Mountain	
No record	1,940
Gray-white limestone; leaves much residue when treated with acid	1,980
Brownish white limestone	2,000

Gray-white limestone; leaves much residue when treated with acid	2,070	
Red soft shale	2,080	
Pinkish hard limestone	2,130	
Red limy shale	2,160	
Pinkish limestone	2,190	
Pinkish dolomite and red shale	2,210	
Cream-colored dolomite. At 2,210 feet strophomenoid brachiopod and undetermined bryozoan; at 2,220 feet, *Dalmanella*, unnamed species which also occurs in beds of Richmond age of southern Minnesota, and undetermined bryozoan; at 2,230 feet, orthid brachiopod, undetermined	2,260	
Cream-colored dolomite and red shale	2,330	
Cream-colored dolomite	2,380	
Light gray limestone; leaves much residue in dilute acid	2,430	
Cream-colored dolomite	2,480	
Cream-colored dolomite and red shale	2,495	
Cream-colored dolomite	2,515	
Light gray limestone; leaves much residue in dilute acid	2,525	
Pinkish dolomite and shale	2,530	
Cream-colored dolomite. At 2,530 feet *Bythopora* sp. and *Zygospira* sp.; at 2,535 feet *Hallopora* sp., quadrangular columnals of *Xenocrinus?*, *Zygospira* sp., and fragments of other brachiopods; at 2,450 feet, barrel-shaped columnals of crinoid characteristic of Richmond	2,550	
Red River		
Cream-colored dolomite and pinkish shale	2,590	
Gray limestone, leaves much residue in acid	2,595	
Cream-colored dolomite and red and gray shale	2,660	
Light gray limestone and shale	2,675	
Gray shale and limestone	2,690	
Cream-colored dolomite and gray shale	2,720	
Light gray limestone and shale	2,730	
Cream-colored dolomite	2,740	
Gray-white limestone and bluish gray shale. Indeterminate columnals and brachiopod fragment	2,750	
Winnipeg		
Blue-gray shale and reddish brown shale; a piece of brownish gray limestone from this interval preserves fragment of phosphatic linguloid brachiopod at 2,890 feet (concretion?)	2,890	
Red sandy shale	2,980	
Cambrian (?)		
Deadwood (?)		
Red, green, and gray sandstone; glauconite and quartz the conspicuous minerals; in part fine-grained, in part coarse, especially coarse at 3,000 feet	3,020	
Dark brown coarse glauconitic and micaceous sands	3,030	
Dark brown fine glauconitic sand	3,050	
Red and gray shale	3,065	
Dark brown sand	3,100	
Olive-drab to rusty brown micaceous sand, mostly very fine-grained but in part medium-grained	3,150	
Pre-Cambrian		
Granite gneiss	3,166	
No cuttings, presumably crystalline rocks	3,240	T. D.

PRAIRIE OIL AND GAS COMPANY, KIDDER COUNTY
Sec. 2, T. 140 N., R. 73 W.

Pleistocene		
Drift		
Yellow clay	12	
Gravel and yellow clay	56	

Cretaceous		
	Pierre	
		Blue shale 80
		Sandy shale, hole full of water 160
		Blue-gray shale 245
		Green shale 255
		Blue-gray shale 595
		Bentonite 610
		Blue-gray shale 1,160
		Lime shell 1,162
		Black shale 1,205
		Dark shale 1,255
		Gray shale 1,288
		Lime shell 1,295
		Sandy shale 1,325
		Blue-gray shale 1,560
		Lime shell 1,565
		Gray shale 1,620
		Lime shell 1,624
		Gray shale 1,710
		Dark shale 1,780
		Dark sandy shale 1,790
	Niobrara	
		Gray shale 1,825
		Gray sandy shale 1,838
		Hard shell 1,840
		Dark sand 1,855
		Dark lime 1,870
	Benton	
		Dark gray shale 2,100
		Light gray shale 2,345
	Dakota	
		Dakota sandstone, hole full of water 2,375
	Fuson	
		White shale 2,385
		Lime 2,395
		White shale 2,435
		Gray shale 2,457
	Lakota	
		White sand, water 2,515
		Gray and white shale 2,535
Devonian		
		Red rock 2,540
		Blue shale 2,545
		Red shale 2,565
		Gray shale 2,575
		Red rock 2,620
		Blue-gray shale 2,740
		Red shale 2,768
		Dark coarse sand, hole full of salt water 2,770
		Red sandy shale 2,780
		Red shale 2,815
		Red sand 2,825
		Red shale 2,850
		White shale 2,865
		Red rock 2,870
		White lime 2,875
		Red shale 2,890
		White shale 2,895
		Red shale 2,950
		Lime shell 2,960
		Red shale 2,989

Silurian-Ordovician		
Stonewall-Stony Mountain		
Gray lime	3,050	
Sandy lime	3,065	
Dark lime	3,090	
Sandy lime, salt water at 3,090	3,095	
Dark lime	3,140	
Gray shale	3,148	
Sandy lime	3,155	
Dark lime	3,185	
White lime	3,195	
Dark lime, salt water at 3,220	3,260	
Sand, salt water	3,265	
Hard gray lime	3,315	
White lime	3,325	
Hard lime	3,373	
Red sand	3,377	
Hard lime	3,467	
Red River		
White shale	3,477	
Light gray shale	3,495	
Lime	3,505	
Light gray shale	3,515	
Light gray shale	3,525	
Lime	3,532	
Light lime or sand	3,542	
Lime or shale	3,592	
Lime or sand	3,605	
Winnipeg		
Light gray shale	3,645	
White shale	3,652	
Light gray shale	3,693	
Brown shale	3,700	
Brown sandy shale	3,710	
Brown shale	3,715	
Light gray shale	3,745	
Brown sandy shale	3,755	
Gray lime	3,760	
Light gray shale	3,795	
Dark gray shale	3,814	
Dark gray shale, sandy	3,819	
Cambrian (?)		
Deadwood (?)		
Gray sand	3,843	
Dark sandy shale	3,851	
Dark sand	3,884	T. D.

D. J. CARTER AND COMPANY'S WELL NO. 1, LOGAN COUNTY
SW. ¼ Sec. 26, T. 133 N., R. 72 W.

Pleistocene	
Drift	
Quicksand and water	22
"Pierre shale"	88
Sand, water	95
Cretaceous	
Fox Hills	
Gray sandy shale	137
Pierre	
Blue shale, caves badly	515
Pierre shale, stood up well	710
Lime, hard	720
Blue shale, stood up well	902

Hard shell	908
Pierre shale, quite a little bentonite	1,100
Black shale, some shells	1,190
Niobrara	
Light gray shale	1,340
Hard shell	1,343
Light gray shale	1,370
Benton	
Little darker shale with some sand	1,460
Very dark shale	1,700
Very dark shale with lime shells	1,741
Hard shell	1,746
Very dark shale with lime shells	2,020
Dark shale	2,091
Dakota	
Cap rock	2,092
Soft white sand, water	2,098
Soft brown sand, show oil	2,107
Fuson	
Hard gray shale with bentonite	2,109
Laminated sandy shale, oil show	2,152
Dark shale saturated with oil and gas	2,166
Light gray sandy shale	2,176
Gray sandy shale, oil colors	2,192
Lakota	
Sticky green sand, show oil and gas	2,205
Very dark shale with green sand, show oil and gas	2,276
Very hard cap rock, iron pyrite	2,279

COMMONWEALTH OIL AND GAS COMPANY'S MANITOU NO. 2, MANITOBA

L. S. 8, Sec. 26, T. 2, R. 9, W. 1st Mer.

(R. T. D. Wickenden, and F. J. Fraser, *Canada Geol. Survey, Summ. Rept.* (1932), Pt. B., pp. 91–93. See also G. S. Hume in *Econ. Ser. 5* (1933), p. 286)

Drift	100
Upper Cretaceous	
Boyne and Morden beds	
Missing	140
Shale, dark gray	180
Missing	200
shale, dark gray	300
Missing	320
Shale, dark gray	340
Assiniboine and Keld beds	
Shale, dark gray	450
Limestone	460
Shale, dark gray	600
Ashville and basal Upper Cretaceous beds	
Shale, dark gray	670
Missing	700
Shale, medium gray	705
Sand, light gray to white	735
Lower Cretaceous (?)	
Shale, medium gray	755
Shale, light gray	764
Shale, light gray and reddish brown	780
Shale, light gray	820
Shale, medium gray	855
Shale, reddish brown and gray	860
Shale, medium gray	870
Shale, reddish brown	880
Shale, medium gray	890
Shale, reddish brown and gray	895

	Sand, light gray to white	900
Jurassic		
	Shale, medium gray	970
	Shale, variegated, reddish brown, green, white and yellow	1,090
	Shale, light gray and white, some gypsum	1,110
Devonian		
	Dolomite, light buff and gray	1,140
	Shale, light gray, some sand at 1,150–1,160 feet	1,200
	Missing	1,210
	Shale, cream-colored	1,220
	Shale, reddish brown, gray and white, much gypsum	1,270
	Shale, gray and reddish brown	1,280
	Shale, reddish brown	1,300
	Missing	1,340
	Shale, reddish brown, much gypsum	1,390
	Sand, quartz, reddish stain, medium- to coarse-grained, well rounded	1,400
	Shale, reddish brown	1,430
	Limestone, dirty cream	1,450
	Dolomite, mauve to pink	1,470
	Shale, brick red	1,490
Silurian (?)		
	Dolomite, pink	1,500
	Limestone, pink	1,510
	Limestone, light gray	1,530
	Dolomite, pink	1,540
	Dolomite, cream-colored	1,550
	Dolomite, pink	1,570
	Limestone, cream-colored	1,580
	Dolomite, pink	1,600
	Limestone, cream-colored	1,620
	Dolomite, pink	1,705
	Dolomite, cream-colored	1,790
	Shale, brick red; sand, quartz	1,800
	Dolomite, pink	1,850
	Dolomite, brown and gray	1,870
	Sandy dolomite, gray	1,890
	Dolomitic sandstone	1,900
Ordovician		
Stony Mountain		
	Sandy dolomite and calcareous shale	1,910
	Limestone, medium gray	1,933
	Sand, light gray	1,935
	Missing	1,940
	Dolomite, light gray	1,980
	Dolomite, medium gray	2,000
	Dolomite, buff and gray	2,017
Red River		
	Dolomite, cream	2,030
	Dolomite, medium gray	2,040
	Dolomite, buff and gray	2,045
	Dolomite, light buff	2,055
	Dolomite, cream-colored	2,080
	Limestone, cream-colored	2,130
	Limestone, cream-colored	2,290
	Dolomite, cream-colored	2,340
	Calcareous mud	2,350
	Limestone, cream-colored	2,360
	Calcareous mud	2,370
	Dolomitic mud	2,380
	Calcareous mud	2,390
	Limestone, cream-colored	2,400
	Dolomitic mud	2,430

Calcareous mud	2,440	
Dolomitic mud	2,450	
Calcareous mud	2,480	
Winnipeg		
Shale, dull green	2,600	
Sand, medium-grained, quartz	2,602	
"Arkose," green-gray	2,612	
Shale, dull green	2,613	
Pre-Cambrian		
"Granite," brown stained, much decomposed, much biotite	2,639	T. D.

MORDEN, MANITOBA

(J. B. Tyrrell, *Roy. Soc. Canada*, Vol. IX (1891) IV, p. 98)

Alluvium	
Soil, light, sandy	8
Quicksand	11
Quicksand, red	12
Gravel, fine, red	15
Till	
Clay, lead-colored, with pebbles	25
Limestone boulder, with fine scratches	27½
Boulders, small, and shale	31
Pierre	
Shale, dark gray	55
Niobrara	
Streak, hard	55½
Shale, dark gray	60
Streak, hard	63
Shale, dark gray	69
Streak, hard	70
Shale, dark gray	81
Streak, hard, mixture of stones and shale	82
Shale, dark gray	86
Shale, black, very gritty	87
Shale, dark gray	94
Shale, black, hard, and gritty	95
Shale, gray calcareous	216
Benton	
Shale, dark gray	251
Soapstone	254
Shale, dark gray	321
Dakota	
Sand, white, with water	325
Sand, white, with particles of coal	379
Shale, white and white sand	381
Shale, soft, gray	391
Shale, black	401
Shale, gray, with sandstone	413
Devonian	
Shale, red and gray	501
Limestone, porous	
Shale, red and gray	601

DES LACS WESTERN OIL COMPANY'S BLUM NO. 1

SW. ¼ Sec. 4, T. 155 N., R. 85 W.

(Log and formation tops by J. B. Reeside, Jr., from samples, *U. S. Dept. Interior Press Release*)

Pleistocene	
Glacial drift	60

Tertiary (Eocene)	
Fort Union	
Gray, rather calcareous sandy clay, with streaks of limestone, sandstone, and lignite. Hard layer, with show of gas beneath, reported by driller at 210	590
Lignite	598
Sandy clay, in part calcareous	900
Fine quartz sand, reported by driller to show oil	920
Tertiary (?) (Eocene?)	
Lance	
Dark sandy calcareous shale, containing lignite and fragments of limestone	960
Gray muddy shale	1,050
Gray sandy clay, with some carbonaceous matter	1,075
Gray gumbo, with fragments of high-colored limestone	1,125
Gray fine-grained shaly sandstone	1,160
Gray soft sticky shale	1,300
Upper Cretaceous	
Fox Hills	
No cuttings; reported by driller as sandstone, with good showing of oil and gas	1,340
Pierre	
Light gray shale with calcareous layers	1,900
No cuttings; reported by driller as limestone with good showing of oil	1,905
Gray shale	1,960
Light gray shaly limestone with fragments of fossils	1,980
Gray shale with calcareous layers	?
Whitish clay	2,165
Gray, rather calcareous shale	2,300
Gray calcareous shale and limestone. According to driller's report there is sandy shale and sandstone, showing 1–10 barrels of oil a day, between 2,300 and 2,310 feet, which may correspond with gas sand of gas field at Glendive, Montana	2,330
Gray calcareous shale; fossil fragments at 2,650 feet	2,820
Gray shaly limestone, with *Ostrea* and *Inoceramus*	2,830
Whitish shaly limestone	2,833
Gray crumbly shale	2,878
Blue limestone, with *Inoceramus* and *Ostrea congesta;* probably corresponds with Eagle formation	2,900
Dark crumbly calcareous shale. Blue limestone containing pyrite and fossils at 2,995–3,030 feet. Driller reports sandstone showing 1–10 barrels of oil a day at 3,040–3,043 feet. This unit probably corresponds with Telegraph Creek formation of southern Montana	3,133
Niobrara	
Blue limestone with *Baculites*, *Inoceramus* and *Ostrea*	3,140
Dark blue to black calcareous shale and limestone, with *Ostrea congesta* and abundant fragments of thick-shelled *Inoceramus*	3,400
Benton	
Dark gummy, somewhat calcareous shale	3,476
Dark gray, rather splintery shale; fragments of fossils	3,500
Dark, rather gummy shale. According to driller, limestone and limy shale at 3,460–3,560 feet	3,650
Dark hard massive, fairly calcareous shale	3,856
Gray limestone	3,860
Dark massive shale	3,880
Massive gray limestone	3,890
Dark gray shale with limestone and *Inoceramus*	3,909

Dakota		
	Quartz sand	3,924
	Hard dark, rather calcareous shale, with *Inoceramus*	3,980

A. R. JONES OIL AND OPERATING COMPANY'S GEHRINGER NO. 1
SE. ¼ Sec. 17, T. 161 N., R. 84 W., Renville County

Pleistocene		
Drift		
	Surface soil	60
	Sand or gravel	65
Tertiary		
Fort Union		
	Gray sandy shale	95
	Sand and gravel, water	100
	Sand	115
	Sand and gravel	125
	Sandy shale	170
	Gray sandy shale	195
	Gray shale	268
	Shell	270
	Shale gas	272
Cretaceous		
Lance		
	Brown shale	285
	Blue shale	295
	Shell	296
	Sand and gravel, water rose 70 feet in hole, tasted salty	315
	Black shale	320
	Gray lime	322
	Black shale	325
	Coal	330
	Gray sandy shale	355
	Gray shale	378
	Shell	379
	Brown shale	490
Fox Hills		
	Gray sandy shale	600
Pierre		
	Brown shale	620
	Gray stocky shale	650
	Brown shale	655
	Gray shale	660
	Blue shale	670
	Gray shale	795
	Brown shale	835
	Gray shale	845
	Conglomerated shale	850
	Gray shale	900
	Blue shale	960
	Gray-blue shale	995
	Blue shale	1,070
	Bluish black shale	1,095
	Light blue heavy shale	1,115
	Gray shale	1,155
	Blue shale	1,425
	Lime shell	1,426
	Blue shale	1,479
	Lime shell	1,480
	Blue shale	1,510
	Brown shale	1,545
	Blue shale	1,645
	Gray shale	1,750
	Mixed gray and brown shale	1,845

	Blue shale	1,870
	Gray shale, trace of oil	1,910
	Mixed brown and black shale	2,040
	Black shale	2,180
	Gray shale	2,220
	Brown shale	2,345
	Blue shale	2,370
	Brown shale	2,420
Niobrara		
	Black shale and lime, trace of oil and gas	2,505
	Lime	2,510
	Brown lime and shale	2,600
Benton		
	Brown shale	2,655
	Gray and blue shale	3,000
	Gray shale	3,035
	Blue shale	3,050
	Sand, dry	3,060
	Dark shale	3,095
	Sandy lime	3,109
	Red rock	3,110
	Shale	3,200
Dakota		
	Broken lime and sand, hole full of water	3,215
	Hard lime and sand	3,219
	Sandy lime	3,240
Fuson		
	Sandy shale	3,250
	Shale	3,260
	Sandy shale	3,270
Lakota		
	Pure white sand	3,290
	Shell	3,300
	Shale	3,310
	Sand	3,312
	Shale	3,315
	Sand, water	3,330
	Sand, gas	3,340
Jurassic		
	Gray shale, show gas	3,370
	Sandy gray shale	3,390
	Sandy shale	3,400
	Gray shale	3,410
	Shale	3,430
	Lime shell	3,441
	Lime	3,445
	Blue lime	3,450
	Lime with shale breaks	3,460
	Shale	3,470
	Broken lime and shale	3,485
	Shale	3,500
	Sandy lime, some sulphur water	3,505
	Shale	3,525
	Blue shale	3,737
	Red slate	3,740
	Shale	3,835
	Sandy lime	3,842
	Lime	3,844
	Sand	3,855
	Shale	3,858
	Sandy lime	3,863
	Sand	3,865
	Shale	3,872 T. D.

MEDORA, BILLINGS COUNTY
Sec. 27, T. 140 N., R. 102 W.
(*U. S. Geol. Survey Water-Supply Paper 598*, p. 78)

Tertiary	
Fort Union	
Sand	30
Coal	31
Soapstone	75
Coal	75½
Soapstone and sand	123
Coal	146
Soapstone and sand	186
Quicksand	271
Soapstone	276
Coal	278
Soapstone and sandstone	364
Coal	393
Sandstone and shale	416
Coal	418
Soapstone	436
Hard sandrock	441
Soapstone	465
Coal	468
Soapstone	506
Coal	508
Soapstone	520
Coal	522
Soapstone	536
Hard sandrock	541
Fossil shells, soapstone and sandstone	591
Quicksand	626
Coal	628
Soapstone	631
Coal	636
Soapstone	691
Soapstone with fossils	693
Quicksand	711
Soapstone	761
Coal	766
Soapstone	844
Coal	847
Soapstone	882
Coal	883
Soapstone and sandstone	915
Coal	916
Coarse soft sand	931
Sand and gravel	941 T. D.

THE CALIFORNIA COMPANY'S KAMP NO. 1, WILLIAMS COUNTY
C. NW., NE., Lot 2, Sec. 3, T. 154 N., R. 96 W.

(Commenced 9/28/37, completed 8/15/38. Elev., 1926 RT. Log furnished to North Dakota Geological Survey by The California Company)

Recent	
River deposits, clay, shells, some lignite	100
Tertiary-Cretaceous	
Fort Union-Lance	
Thin beds of lignite, light limy sand; yellow, gray and somber-colored shales; white clay, gray gumbo, gray sandy shale, coarse sand, gravel, limonite, light concretionary lime, tan and gray chert, shells	740

Cretaceous	
Fox Hills	
Medium hard, fairly dark gray, fine sandy shale, lignite, gray gumbo, light brown and tan chert, coarse	850
Pierre	
Limy coarse-grained sandstone	1,030
Light gray massive and flaky shale, trace lignite, massive light limy material 1,060–1,100	1,160
Medium-grained friable water sand gumbo, flaky gray shale	1,220
Soft gray and greenish gray shale and gumbo, small amount of limonite, chalk, shell fragments, calcite, trace of oily shale at 1,990	1,990
Soft gray massive and flaky shale, gray sandy shale, greenish gray and gray fine sandstone, light brown lime, trace of calcite, shell fragments	2,330
Soft gray flaky and massive shale, sandy shale, trace black limestone, limonite, calcite	2,400
Bluish gray shale, some pyrite and bentonite	2,550
Bluish gray shale and light brown shale	2,720
Bluish gray shale	2,830
Bluish gray shale and some light brown shale	2,880
Bluish gray shale	2,910
Bluish gray shale and brown shale	2,920
Bluish gray shale, trace of sand	3,000
Greenish gray shale, trace of sand	3,070
Greenish gray shale, some white calcareous material, trace of sand	3,100
Greenish gray to dark gray shale, trace of sand	3,250
Greenish gray to dark gray shale, trace of white calcareous material and sand	3,290
Grayish green and dark gray to black shale, trace of sand	3,420
Niobrara	
Dark gray shale with a little grayish green shale, dark lime and calcareous shale, trace of sand	3,580
Benton	
Dark laminated to massive gray shale, some light grayish green shale, very small amounts of sand 3,935–3,945	4,165
Dakota	
Dark gray laminated and massive shale, massive chocolate-brown sandy shale with inclusions of plant fragments, dark gray laminated shale and interbedded fine gray sand	4,365
Dark laminated gray shale and white to brown, medium-grained, well rounded quartz sandstone	4,395
Dark laminated gray shale	4,465
Fine-grained, compact, white to gray, non-calcareous sand and dark laminated gray shale	4,508
Gray to light brown sandy shale, chocolate and very dark brown shale, non-calcareous medium-grained gray to finer brown sand, greenish gray and dark gray laminated and massive shale, and soft greenish gray and hard gray sandy shale	4,541
Dark laminated gray to brownish black shale, thin beds of light fine-grained gray to brownish sand	4,645
Jurassic	
Morrison	
Dark laminated gray shale and gray and green shale with minor amounts of gray-green, pinkish brown and reddish brown shales. Variegation here is extremely weak	4,830
Sundance	
Light splintery and flaky green shale with thin beds of hard, fine, grayish to white calcareous sand	4,922
Alternating thin beds of hard gray and greenish gray calcareous sandy shale and light green splintery, laminated, greasy-looking shale	4,937

Flaky and splintery light green shale	5,035
Light to dark green flaky shale, traces of black limy shale	5,135
Dark to light greenish gray shale (flaky), small amount of lime	5,145
Dark to light greenish gray shale (flaky), less lime	5,155
Dark to light greenish gray shale, small amounts of pinkish brown shale and hard tan limy shale	5,170
Same, with dark reddish brown limy shale	5,190
Greenish gray and gray, brittle, flaky shale, hard tan limy shale and some fine gray very limy sand	5,205
Greenish gray and gray brittle, flaky shale, traces gypsum 5,205–5,265. Shales becoming darker	5,265
Black lime, tan lime, and limy sand interbedded with light to dark gray shale	5,315
Variegated shale, considerable light limy sand at 5,345	5,360
Light hard and soft lime	5,410
Flaky, dark greenish gray shale with some dark gray shale	5,430
Light limestone	5,480
Dark greenish gray to gray and black shale	5,490
Light limestone	5,550
Gypsum and lime, salmon-colored shale coming in	5,580
Light-colored	5,585
Pre-Jurassic undivided	
Bright red limy shale and dark gray to black shale	5,620
Red shale, some limy and some sandy, mottled	5,700
Deep red to brown shale and sandy bright red shale	5,765
Considerable light gray to dark shale, minor amounts of red and brown shale	5,790
Light to dark shale, gray, with brown and deep red shale and red sandy shale	5,850
Light to dark gray shale, considerable brown and deep red shale and red sandy shale. Considerable black shale at 5,860	5,900
Hard light to dark gray shale	5,925
Soft black shale, considerable bright red shale and sandstone 5,935–5,940	5,960
Brick red shale, limy, bright red sandstone, light to dark gray shale	5,980
Bright red limy sandstone, brick red shale, light to dark gray shale	6,020
Bright red limy sandstone, fine brick red shale	6,040
Pinkish lime and gypsum	6,050
Hard light to dark gray and black shale	6,090
Brick red shale, light lime 6,105–6,110	6,110
Light to dark gray shale, light lime, brick red shale, red coming in	6,140
Hard gray, brown, deep red and bright red shale with disseminated anhydrite	6,254
Hard bright red shale, salt	6,264
Bright red shale, hard and somewhat limy	6,377
Hard light and dark gray shale and bright red shale	6,400
Bright red shale	6,485
Very light dolomite, some dolomitic red shale	6,561
Red shale	6,590
Light to deep purple well rounded sand; laminated deep red shale; vuggy fine red sandstone; deep purple shale	6,645
Soft, light to dark gray shale and greenish gray shale	6,650
Massive deep maroon shale; laminated, splintery, brick red shale; light to dark purple shale (locally with crystalline lime); white medium-grained non-calcareous quartz sand, grains mostly angular; fairly soft, laminated black shale with green cast; light limy sand with greenish cast	6,671
Laminated purple shale interbedded with thin streaks of deep purple eolian sand, and light gray to violet shale; white	

to dark brown and reddish fine-grained sandstone. Some sand-filled fissures	6,679
Fairly hard, light to dark purple laminated shale interbedded with thin layers of deep purple, well rounded sand; some deep red well rounded sand with lime cement, and white, compact, angular-grained sand	6,693
Sand as above, with hard laminated deep red, non-calcareous shale, and deep purple laminated shale showing joints	6,726
Laminated, light and dark purple shale, jointed, grades into gray and back into purple	6,736
Laminated, non-calcareous black shale; dark gray, dense, hard fine sand and sandy shale; laminated black shale with limestone-filled fissures, some pyrite as replacement in the black shale	6,747
Flaky and splintery black shale, some limy; coal 6,780–6,785; splintery soapy shale 6,760–6,770	6,815
Flaky and splintery black shale and coal	6,825
Soapy and flaky gray shale	6,860
Variegated shale, brown, tan, red and purple	6,870
Black shale, coal, gray shale, small amount of dolomitic lime 6,875–6,880	6,880
Dolomitic lime, anhydrite closely associated with lime; soapy and flaky gray lime	6,905
Deep red, brown, tan and purple shale	6,910
Gray lime and dark gray shale	6,925
Light dolomite	6,930
Soapy and flaky gray shale	6,965
Gray and brown dolomitic lime	6,988
Interbedded thin layers of gray limy shale, red limy shale showing mottling, with gradations into deep purple and red shale, inclusions of anhydrite in red shale. Contacts between small units ordinarly sharp. Black indurated sand	7,006
Red shale, anhydrite, gray and black shale	7,025
Light and dark gray shale and red and white fine sandstone	7,060
Light gray and pink limy fine sandstone and anhydrite	7,070
Fine red limy sand, red sandy shale with small amounts of muscovite; medium-grained white, pink, and red sand with included anhydrite, very thin beds of purple and bright green shale; red shale	7,175
Anhydrite	7,185
Soft gray and brown lime	7,200
Soft and hard brown lime containing much salt	7,217
Very fine limy gray sand	7,237
Hard buff to pink, slightly limy sandy shale with some included anhydrite, interbedded with hard limy white fine-grained sand, deep red sandy shale and red shale	7,273
Soft flaky gray shale, some limy	7,296
Hard, slightly limy red sandy shale and red shale, both with mottling and containing included anhydrite; soft red shale	7,330
Red shale and sandy shale with salt and anhydrite	7,354
Transparent crystalline salt with some included red shale	7,363
Red and gray shale in salt	7,380
Transparent crystalline salt with some included red shale	7,389
Red shale and salt	7,427
Hard red shale and pink anhydrite, salt	7,505
Anhydrite, some dolomite and red shale	7,520
Very fine limy sandstone	7,525
Red shale and anhydrite, salt	7,545
Red and gray shale interbedded with and included in transparent crystalline salt	7,554
Red shale and anhydrite, salt	7,565
Red shale, gray and black shale and anhydrite, salt	7,645
Anhydrite	7,670

Red shale and anhydrite	7,695
Transparent crystalline salt with included soft gray clay	7,705
Anhydrite and lime	7,710
Hard brown vuggy lime, anhydrite	7,737
Anhydrite and fine light gray sand	7,746
Oölitic salty brown lime	7,748
Oölitic, very salty brown lime; dense light brown lime; gray clay and anhydrite	7,756
Limestone and anhydrite, brown	7,780
Anhydrite and gray shale	7,795
Soft gray shale	7,810
Brown lime, gray shale and anhydrite	7,825
Soft gray shale	7,835
Anhydrite	7,850
Hard and soft gray shale	7,865
Brown limestone and anhydrite	7,890
Brown lime, gray dolomite and anhydrite	7,900
Brown lime	7,920
Gray dolomite and anhydrite	7,930
Anhydrite and gray dolomite	7,950
Brown lime and anhydrite	7,965
Gray dolomite and anhydrite	7,972
Soft light gray shale	8,000
Anhydrite and dolomite	8,017
Dolomite	8,025
Light lime and brown lime	8,035
Gray lime and dolomite	8,052
Brownish and white anhydrite included in dense brown dolomite	8,057
Brown dolomite	8,080
Brown dolomite and anhydrite	8,130
Brown lime	8,150
Softer brown lime, some oölitic	8,160
Dense hard brown and dark brown lime	8,206
Dark gray and brown limestone	8,211
Dense and softer oölitic brown lime, some anhydrite	8,231
Light gray to tan, rather dense lime with small included masses of crystalline calcite, surface stained black; dense grayish brown lime	8,240
Light rather hard limestone and hard dense grayish brown lime	8,265
Light and dark brown lime	8,418
Hard very dark brown and gray lime containing small masses of calcite and included white anhydrite, hydrogen sulphide odor	8,421
Same as above; some banded anhydrite and calcite; fine laminations	8,455
Soft medium brown lime	8,456½
Light and dark brown and gray lime, small amounts of anhydrite	8,610
Light and dark brown and gray lime	8,631
Black shale and light fairly hard lime (lime predominant)	8,636
Fairly hard, light tan to gray highly crystalline lime, hard black cherty lime	8,645
Hard cherty black lime and light tan to gray highly crystalline lime	8,685
Hard black and dark brown lime, also light to dark brown and gray lime, grading into one another	8,778
Hard flaky medium brown and gray lime, some included calcite. Gray lime important 9,300–9,325	9,540
Soft flaky black slightly dolomitic shale	9,544
Fairly hard non-calcareous fossiliferous black shale. Small amount gas. Fairly hard light gray lime	9,561
Flaky black shale	9,568

Flaky gray and brown lime	9,598	
Flaky black shale	9,625	
Pink dolomite and black with some medium brown and gray lime	9,650	
Medium brown and gray lime	9,655	
Pink dolomite	9,665	
Medium brown and gray lime, gray increasingly important, some gray dolomite 9,690–9,705	9,705	
Brown and gray lime	9,720	
Slick grayish green dolomitic shale with some brown and gray lime	9,735	
Pink to maroon dolomitic shale, some anhydrite	9,760	
Grayish green dolomitic shale with some anhydrite	9,795	
Maroon and pink dolomitic shale	9,805	
Grayish green dolomitic shale	9,810	
Flaky brown lime decreasing to 9,860, then increasing to 9,891. Flaky light tan and gray lime increasing from 9,825 to 9,860, then decreasing to 9,880	9,891	
Fairly hard flaky dark brown lime; hard fossiliferous brown lime; H_2S odor when struck; hard dolomitic shale; small amounts of pyrite and hard brown dolomitic shale	9,920	
Light tan to gray and dark brown flaky lime and dolomitic lime	9,980	
Fairly hard anhydrite with mottled appearance, small amount of pyrite and some hard gray shale	9,990	
Light tan to gray crystalline mixture of anhydrite and dolomite, a very small amount of gas and the odor of oil; fairly hard dark brown finely crystalline lime	9,998	
Hard flaky medium to dark brown finely crystalline lime, influx of light lime 10,020–10,025	10,050	
Fine sugary brown lime	10,065	
Dense flaky brown lime	10,076	
Hard medium and dark brown dense and very finely crystalline lime. Small amount of black filling, showing flow (?) in hard fractured gray dolomitic shale somewhat mottled with brownish shale, contains fine stringers of transparent crystalline anhydrite, small amount of pyrite and extremely fine sand. Hard light bluish gray dolomitic shale	10,094	
Hard medium and dark brown dense and very finely crystalline lime	10,145	
Medium brown sugar-like lime, slightly dolomitic in places	10,201	
Massive and laminated finely crystalline lime, some anhydrite	10,219	
Light and dark brown finely crystalline limestone	10,281	T. D.

MONTANA-DAKOTA UTILITIES COMPANY'S N. P. R. R. COMPANY NO. 1
Sec. 17, T. 4 N., R. 6 E., Fallon County, Montana
(Generalized log by the company)

Cretaceous		
Pierre		
Gray shale	528	
Sandstone and gray shale, first gas probably 528	717	
Gray shale	1,032	
Gray shale and a little sandstone	1,167	
Sandstone and gray shale, second gas sand probably 1,167	1,438	
Gray shale and a little sandstone	1,685	
Soft gray shale with traces of limestone, sandstone and sandy shale	2,032	
Brown, buff and grayish speckled, thinly laminated, calcareous shale with some traces of sandstone and limestone	2,220	
Soft, gray shale and brownish buff, and grayish speckled, thinly laminated, calcareous shale with some traces of sandstone and limestone	2,329	
Soft gray shale and sandstone	2,344	
Soft gray shale with traces of limestone and sandstone	2,550	

Gray shale, chalky gray sandstone and sandy shale	2,584
Gray shale with thin sand lamination	2,615
Gray shale with a little limestone	2,645
Niobrara	
Dark gray calcareous fossiliferous shale with gray crystalline limestone 2,650–2,651	2,662
Gray shale with traces of limestone and a little sandstone	2,930
Benton	
Gray shale	3,150
Moderately hard grayish brown shale. A few fish scales at 3,150, plentiful at 3,181–3,335	3,335
Hard grayish black shale with fish scales and considerable bentonite	3,405
Fine silty carbonaceous sandstone showing gas at 3,405–3,409, with shale breaks 3,413–3,417 and 3,423–3,425. Gray shale 3,434–3,443	3,443
Fissile, dark, bluish gray shale	3,485
Fissile, medium hard, dark gray, bentonitic, glauconitic shale	3,552
Dark gray fissile shale with a little sandstone throughout	3,644
Dark gray shale with some sandstone	3,724
Dakota	
Sandstone	3,732
Light gray clay-shale	3,739
Sandstone with charcoal and lignite, becoming shaly and bentonitic at base, some siliceous oölites at 3,761½. Oil stain 3,755–3,760	3,766
Grayish brown bentonitic shale	3,778
Sandstone with reddish brown siliceous oölites, somewhat carbonaceous	3,815½
Gray, somewhat sandy shale	3,835
Coarse white sandstone	3,853
Light gray to light pinkish gray shale and some sandstone	3,870
Sandstone	3,933
Jurassic	
Morrison	
Variegated shale	3,945
Variegated clay-shale	4,008
Variegated clay-shale and greenish sandy bentonitic shale, with many ostracod casts	4,025
Sundance	
Greenish shale with considerable sandstone. Two-inch "Oyster" bed at 4,075. First belemnites 4,195	4,222
Greenish shale with considerable limestone	4,243
Greenish shale with considerable sandstone	4,361
Greenish shale with a little sandstone	4,392
Fine light gray sandstone	4,417
Greenish shale with considerable sandstone	4,461
Greenish shale with considerable limestone, slightly sandy at base	4,586
Triassic	
Spearfish	
Red shale and anhydrite	4,616
Greenish gray gypsiferous shale	4,630
Red shale with some anhydrite and a little limestone	4,717
Dense, light brown laminated limestone. Laminations about 1 inch. Fossiliferous	4,732
Hard limy, fossiliferous, gypsiferous, maroon to greenish shale	4,760
Limestone, red shale and anhydrite (oil stain 4,768–4,774)	4,785
Red shale and traces of anhydrite with much sandstone from 4,833 to 4,867	4,911
Red shale	4,930
Red shale with a little sandstone and anhydrite	4,950
Red shale, a little anhydrite and trace limestone	4,960

Red shale	5,000
Red shale and traces anhydrite and salt	5,010
Red shale, traces of anhydrite, probably considerable salt	5,100
Red shale and salt	5,110
Salt, anhydrite, and red shale	5,171
Salt and red shale with traces anhydrite	5,188
Salt, anhydrite, and red shale	5,250
Salt, red beds, and traces anhydrite	5,335
Red shale, salt, and anhydrite	5,350
Red shale and salt	5,360
Red shale and traces anhydrite	5,400
Red shale and traces anhydrite	5,414
Red shale and traces anhydrite	5,440
Permian	
Minnekahta	
Red shale with traces anhydrite and limestone	5,455
Limestone, red shale, and anhydrite	5,480
Limestone, red shale, and a little sandstone	5,497
Opeche	
Red shale with traces anhydrite	5,531
Red shale	5,631
Pennsylvanian	
Tensleep	
White sandstone, showing gas 5,633–5,648	5,671
Hard gray dolomite	5,680
White sandstone	5,733
Amsden	
Dolomite	5,746
Sandstone	5,751
Dolomite	5,765
Dolomite, sandstone, and anhydrite	5,827
Porous, very fossiliferous, somewhat anhydritic (?) dolomite, slightly oölitic, showing gas freely, almost a coquina	5,837
Dolomitic sandstone	5,848
Reddish dolomite with a little anhydrite and red shale	5,916
Reddish to white and gray dolomitic limestone with some red to purple shale	5,968
Red shale	6,047
Gray to brown and purplish dolomitic limestone	6,065
Red to variegated shale with some gray and pink limestone and anhydrite	6,089
Reddish brown to grayish dolomite and yellow, white, pink, and purple limestone	6,115
Mississippian	
Big Snowy	
Red sandstone and red shale	6,179
White anhydrite	6,191
Dark gray to light brown limestone	6,218
Red shale and anhydrite	6,278
White to gray anhydrite and gray to brown limestone	6,379
Dark gray and brown limestone with dark gray shale and white and brown anhydrite (oil stain 6,408–6,423)	6,435
White and gray anhydrite, gray and brown limestone, some dolomitic and dark gray shale	6,514
Brown and gray carbonaceous limestone (oil saturation 6,508–6,523)	6,632
White to blue-gray anhydrite with some limestone and dolomite and dark gray shale	6,747
Brown and light gray limestone, upper portion dolomitic (oil 6,747–6,768 and to 6,797)	6,798
Light gray to light brown limestone, soft and slightly dolomitic, cherty 6,803–6,806 and 6,920–6,925, some oil 6,803–6,840	6,940

White to gray anhydrite with some very dolomitic limestone, traces brown chert 6,945–6,950 — 6,980
Light to dark gray-brown limestone and dolomitic limestone, some very dolomitic, soft. Oölitic to pisolitic 6,985–6,995 and 7,010–7,070. Some oil 6,970–6,985, 7000–7,018 — 7,104
Anhydritic gray-brown dolomite. Showing gas and oil 7,104–7,114 — 7,125
Anhydritic, gray to brown, dolomitic limestone, oölitic to pisolitic 7,125–7,135, slightly oil-stained — 7,165
Reddish gray (some mottled) to gray-white, dolomitic, anhydritic limestone with thin interbedded red to maroon and some light gray shales. Very fossiliferous. Oölitic to pisolitic 7,305–7,335. White chert 7,330–7,335 and 7,365–7,390. Showing of oil and gas 7,225–7,235. — 7,390
Gray-white, very oölitic limestone, some very dolomitic; slight gas odor 7,415–7,420 — 7,440

Madison

Grayish white to light brown, and pinkish, limy dolomite. Some oil 7,476–7,500 — 7,500
Grayish white, pinkish white, and light brown to purplish dolomite with some limestone. Very cherty 7,500–7,520; some chert 7,550–7,572½. Some oil 7,532½–7,572 — 7,575
Maroon to purplish and much light-colored shale with light greenish gray to purplish and maroon dolomite, sandy at top. Traces chert 7,610–7,620. Some oil or gas 7,585–7,590 — 7,620
Grayish, pinkish, brownish white and purplish dolomite. Cherty 7,940–7,955. Showings of oil — 7,955
Whitish to purplish, shaly to silty dolomite, and much maroon to purple, and a little green shale. Some reddish to white chert 8,010–8,015. Oil showing 7,975–7,985; 8,010–8,015 — 8,015
Gray-white to purplish dolomite — 8,055
Gray-white to maroon and light greenish gray dolomite with maroon shale and gypsum — 8,075
Reddish to maroon and purplish limestone with much maroon to red shale and with gypsum 8,075–8,090. Traces white chert 8,120–8,125. Fossiliferous — 8,125
Reddish gray limestone, very fossiliferous — 8,130
Dolomite and dolomitic limestone, fossiliferous. Showing of oil — 8,186

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VOL. 26, NO. 3 (MARCH, 1942), PP. 380-386, 1 FIG.

PRE-CRETACEOUS TOPOGRAPHY OF WESTERN EDWARDS PLATEAU, TEXAS[1]

ERIC H. JAGER[2]
Wichita, Kansas

ABSTRACT

Many references are made to the pre-Cretaceous Wichita paleoplain of R. T. Hill in the geological literature of Texas. Little information is recorded, however, as to the precise nature of this surface or to the amount of its deformation.

It is the purpose of this paper to present at least a regional picture of this interesting old topographic surface.

INTRODUCTION

The western Edwards Plateau as considered here is limited arbitrarily to the area included in Pecos, Crockett, Upton, Reagan, Irion, Glasscock, Sterling, and Terrell counties. This is an area extending approximately 150 miles east and west and 130 miles north and south. The surficial formations are Comanche in age and are little folded.

Deposition took place in this area through much of Paleozoic and a part of Triassic time. During the Jurassic period and the earliest Cretaceous the preëxisting deposits were subjected to erosion and a peneplain was formed. Comanche seas then advanced over the western Edwards Plateau depositing basal Trinity sands, some Glen Rose marls, and later, the limestones and clays of the Fredericksburg and Washita groups.

R. T. Hill[3] named the eroded land surface formed during the Jurassic and earliest Cretaceous periods the Wichita paleoplain. Lon D. Cartwright[4] examined this pre-Cretaceous surface of the eastern part of the Edwards Plateau and constructed contour maps on the base of the basement sands and on the bottom of the Fredericksburg. His work revealed probable islands standing in the Trinity sea and a regional picture of the topography.

It is the purpose of this study to determine the characteristics of the pre-Cretaceous surface of the western Edwards Plateau and to

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[3] E. H. Sellards, "The Geology of Texas, Vol. I, Stratigraphy," *Univ. Texas Bull. 3232* (1932), p. 260.

[4] Lon D. Cartwright, Jr., "Regional Structure of Cretaceous on Edwards Plateau of Southwest Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 16, No. 7 (July, 1932), pp. 691–700.

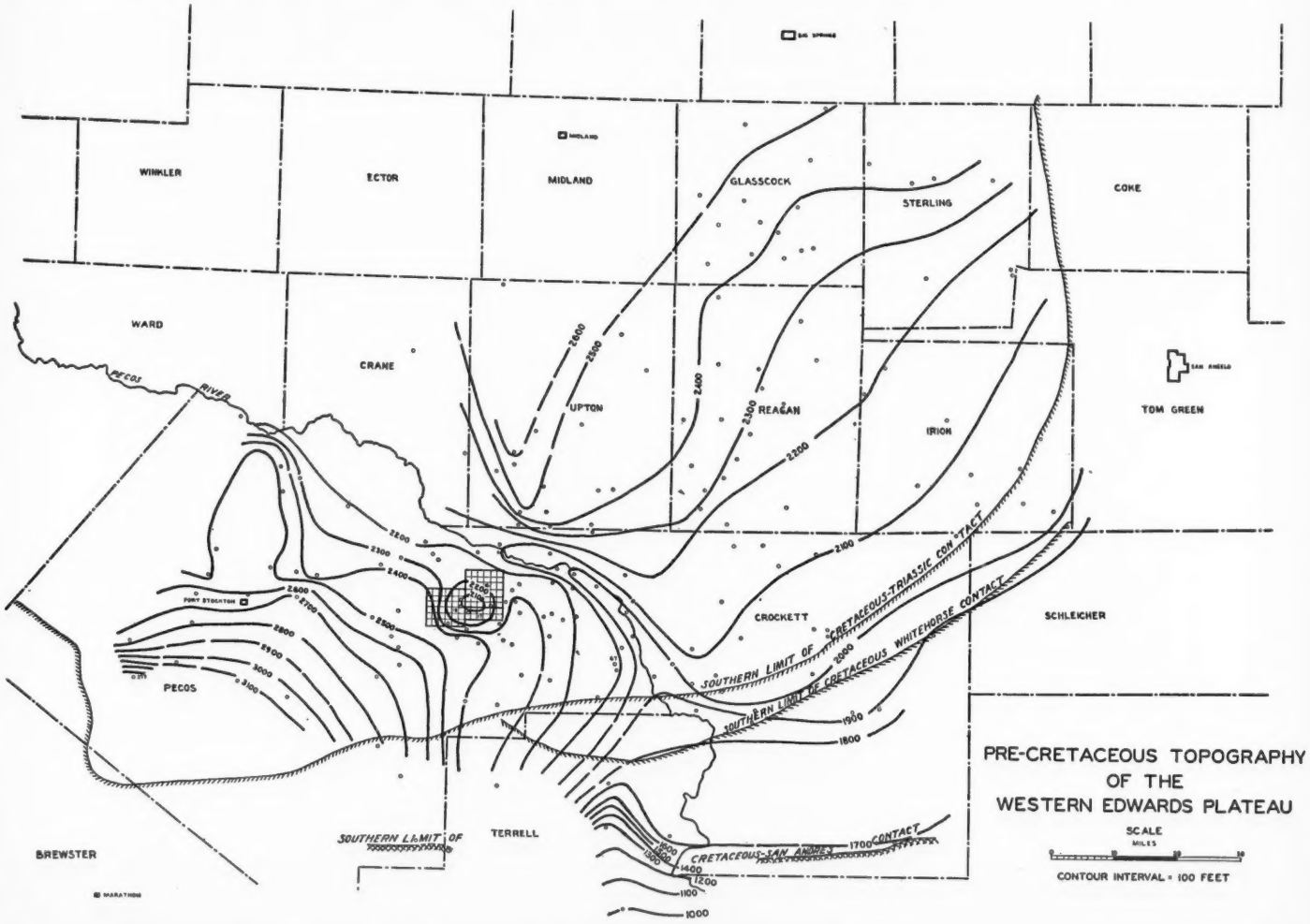

WINKLER
ECTOR
MIDLAND
GLASSCOCK
STERLING
COKE
WARD
CRANE
UPTON
REAGAN
IRION
TOM GREEN
PECOS RIVER
CROCKETT
SCHLEICHER
PECOS
BREWSTER
TERRELL
SOUTHERN LIMIT OF CRETACEOUS-TRIASSIC CONTACT
SOUTHERN LIMIT OF CRETACEOUS WHITEHORSE CONTACT
SOUTHERN LIMIT OF CRETACEOUS-SAN ANDRES CONTACT
PRE-CRETACEOUS TOPOGRAPHY
OF THE
WESTERN EDWARDS PLATEAU
SCALE
MILES
CONTOUR INTERVAL = 100 FEET

FIG. 1

map its topography by means of data obtained from well logs. The area offers unusual opportunities for such a study as a great many well logs are available. Large oil fields of West Texas, including Big Lake, Yates, McCamey, and Taylor-Link, are found in these counties, and many wildcat wells have been drilled. Oil is produced from the Permian and Ordovician formations but samples were taken from the surface down to the producing formations in many of the wells.

PROCEDURE

Well-log strips obtained from University Lands were used to determine the base of the Cretaceous. Sample logs were used almost entirely but at some locations only drillers' logs were available.

In this area little attention is given to the Cretaceous and Triassic samples by petroleum geologists, as the oil-producing structures of the Ordovician and in part those of the Permian formations were developed before the Mesozoic rocks were deposited unconformably above them.

Only in a few places was the base of the Cretaceous indicated by the geologists who examined the samples. Therefore, of the wells used in this study, it was necessary in most instances to select the contact between the Cretaceous and the underlying Triassic or Permian on the basis of comparative lithology. The identification of the contact is difficult where the Cretaceous basal sands overlie redbeds of Triassic or Permian age. The Cretaceous seas reworked the redbeds and the basal Cretaceous sands therefore contained streaks of red sand and clay. Thus the contact is indefinite and difficult to define precisely. The upper part of the basal Cretaceous sand is commonly composed of gray or yellow sands and the bottom part consists of red sands. One could be certain of the Triassic or Permian age of the redbeds indicated by the log strip only where they occurred as a long unbroken series of deposits.

For the foregoing reasons the procedure used to obtain the best results in drawing the Cretaceous-pre-Cretaceous contact was to correlate many logs at one time by taking all the logs available along a certain line or in a given area and placing them in their proper directional sequence. Then, by adjusting the logs with reference to some key horizon, such as the Rustler anhydrite a short distance below the base of the Cretaceous, it was possible to follow the Cretaceous basal sand more or less definitely and to define its boundaries on the basis of comparative lithology. The basal Cretaceous sands are commonly water-bearing, and notations on the driller's log about the water flows encountered in drilling were of assistance.

The elevations at the base of the Cretaceous used for contouring purposes were determined by subtracting the total thickness of the Cretaceous present in a given well from the surface elevation of the same well. In constructing the contour map, 64 well logs were used in Pecos County, 30 in Crockett, 2 in Crane, 16 in Upton, 11 in Irion, 7 in Sterling, 14 in Glasscock, and 5 in Terrell.

PRE-CRETACEOUS AREAL GEOLOGY

The Cretaceous formations rest on Triassic redbeds of the Dockum group over all but a small part of the western Edwards Plateau. The limits of the subsurface Triassic are indicated on the map which forms the principal part of this report. The eastern and southern boundaries are drawn in part on the basis of well logs examined by the writer and in part on the limits defined by John Emery Adams.[5] In the opinion of that author only the Santa Rosa formation of the Triassic is present in Pecos, Crockett, Irion, and Sterling counties.[6] The three divisions of the Triassic in Texas, Tecovas, Santa Rosa, and Chinle, are present beneath the Cretaceous in Reagan and Glasscock counties.[7] Directly underlying the Cretaceous south of the limits of the Triassic are Permian formations as is shown on the accompanying map. A narrow belt of Whitehorse group underlies the Cretaceous in a southwest-northeast strip across Terrell, Crockett, and Irion counties and a wider belt of San Andres beds is present beneath the Cretaceous in an east-west strip across Crockett and Pecos counties. The southern limit of the Cretaceous-San Andres contact as indicated on the map refers only to the area examined and does not refer to the final limit of the subsurface contact.

AGE OF CRETACEOUS AT CONTACT

The lowermost Cretaceous rock over most of the western Edwards Plateau is a basal sand of the Trinity group. P. B. King[8] considers this basal sand in Pecos County to be Paluxy or uppermost Trinity in age. Overlying the basal sand are the limestones and clays of the Fredericksburg and Washita groups. In Terrell County and southernmost Crockett and Pecos counties, however, the Glen Rose limestone is present, which is stratigraphically lower than the Paluxy sand al-

[5] John Emery Adams, "Triassic of West Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 13, No. 8 (August, 1929), p. 1046.

[6] *Ibid.*, p. 1052.

[7] Lincoln R. Page and John Emery Adams, "Stratigraphy, Eastern Midland Basin, Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 1 (January, 1940), p. 56.

[8] P. B. King, "Geology of the Marathon Region, Texas," *U. S. Geol. Survey Prof. Paper 187* (1937), p. 113.

though it is not in contact with it in this area. In the counties north of Pecos and Crockett, Page and Adams[9] have mapped the basal Cretaceous sand as being Paluxy in age.

PRE-CRETACEOUS TOPOGRAPHY

The contours on the old pre-Cretaceous surface reveal a topographic "high" in Upton County and a smooth surface sloping southeast at the rate of 8–10 feet per mile in Glasscock, Sterling, Reagan, and Irion counties. The rate of dip toward the south in Crockett County is 6 feet per mile. An interesting valley-like feature may be noted in the Wichita paleoplain along the Pecos River.[10] The surface in Pecos County rises toward the south 25 feet per mile but the general slope is interrupted by a peculiar low area in Blocks 16 and 18 of the University of Texas Lands. North of Fort Stockton there is a north-trending high area, which is a striking feature of the old land surface. In Terrell County the slope of 60 feet per mile is noteworthy in connection with the thickening of the Cretaceous rocks and the presence of the Glen Rose division of the Trinity group. This part of Terrell County is probably part of the steep slope into the Rio Grande embayment, the old floor of which sank rapidly during Cretaceous time.

Of all the well logs examined, only two sample logs, No. 377 and No. 67 in Pecos County, failed to show a basal sand. These wells are close to other wells in which a basal sand is found. Apparently there were no islands of considerable extent standing in the Trinity seas of this area. It was expected that the basal Cretaceous sand would be thicker in the topographic "lows" and thinner over the "highs" of the paleoplain but this was not found to be the fact. The thickness is found to be irregular and seems to be little affected by the underlying topography. An average thickness of 150 feet for the basal sand was calculated for the entire area.

WARPING OF PRE-CRETACEOUS SURFACE

The paleoplain as contoured has of course been warped somewhat since the deposition of the Cretaceous sediments. Baker[11] states that the Fort Stockton plateau in Pecos County was tilted eastward and uplifted during the late Cenozoic or Cordilleran time in Texas. Sellards[12] states that the area of the Edwards Plateau east of the Pecos

[9] Lincoln R. Page and John Emery Adams, *op. cit.*, p. 56.

[10] This is interpreted by Morgan Roberts to be due in large part to salt solution.—Editorial note.

[11] C. L. Baker and E. H. Sellards, "The Geology of Texas," Vol. II, *Univ. Texas Bull. 3401* (1934), p. 155.

[12] *Ibid.*, p. 86.

River was uplifted in post-Cretaceous time by a continental-like uplift. Salt solution,[13] which may have caused subsidence, probably occurred locally as a great part of the area is underlain by Castile evaporites. No real sink-hole topography is found, however, unless the low area of Blocks 16 and 18 of the University Lands in Pecos County is so interpreted.

A noteworthy feature of the pre-Cretaceous topography is that the Central Basin platform and the Sheffield channel, which are so conspicuous on contour maps of the Permian Yates sand horizon, are not evident as pre-Cretaceous topographic features. This condition might be expected as there is an unconformity at the base of the Triassic as well as at the base of the Cretaceous. The pre-Triassic erosion undoubtedly planed down the Central Basin platform to some extent and the deposition of the Triassic terrestrial deposits helped to obscure the remaining topographic reflection of its structure. The Wichita paleoplain, which was formed before the advance of the Cretaceous seas, removed the last vestige of a reflection of the Central Basin platform.

CONCLUSIONS

1. The pre-Cretaceous (Comanche) surface under the western Edwards Plateau is underlain with Triassic and Permian formations.

2. Considerable topographic relief of the surface is noted in Upton County.

3. A generally smooth surface sloping southeast at the rate of 8–10 feet per mile is present in Glasscock, Sterling, Irion, and Reagan counties.

4. The pre-Cretaceous (Comanche) surface rises south 25 feet per mile in Pecos County but the general slope is broken by some irregularities.

5. The map shows a valley in the Wichita paleoplain along the Pecos River.

6. The pre-Cretaceous (Comanche) surface slopes south 60 feet per mile in Terrell County as the Cretaceous thickens into the Rio Grande embayment.

7. The presence of basal Cretaceous (Comanche) sand in all but two sample logs indicates that there were probably no islands standing above the Trinity (Paluxy) seas of this area.

8. The pre-Cretaceous (Comanche) surface has been uplifted regionally over the entire western Edwards Plateau, and the Fort Stockton plateau has been tilted eastward.

[13] John Emery Adams, "Structural Development, Yates Area, Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 1 (January, 1940), pp. 134–42.

9. Permian structures such as the Central Basin platform and the Sheffield channel are not well reflected on the pre-Cretaceous (Comanche) surface.

10. The average thickness of the basal Cretaceous sand (Paluxy sands and shales) over the entire area is 150 feet.

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BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 3 (MARCH, 1942), PP. 387-401, 6 FIGS.

GEOLOGICAL NOTES

BARNHART FIELD, REAGAN COUNTY, TEXAS[1]

TAYLOR COLE[2]
Midland, Texas

The Barnhart field is in the extreme southeastern part of Reagan County, 9 miles west of Barnhart and about 20 miles southeast of the Big Lake field. It is in the southern part of the Midland basin. The area is traversed by Highway 67 and the Kansas City, Mexico, and Orient Railroad.

The discovery well, the Amerada Petroleum Corporation's University No. 1-RA, Sec. 3, Block 48, University Lands Survey, was completed, September 1, 1941. The well was drilled to 9,294 feet and plugged back to 9,082 feet where its initial production was 1,122 barrels of 44.2° gravity oil through 1-inch tubing choke on 2-inch tubing with a gas-oil ratio of 2140 after acid treatment of 5,000 gallons. The "pay," which was topped at 9,016 feet, is in Ellenburger (Lower Ordovician) dolomite from the top of which approximately 200 feet has been removed by erosion. The porosity is chiefly interstitial in contrast to the porosity of most of the Ellenburger "pays" of West Texas, which is due primarily to fracturing.

The area became one of the major discoveries of the year in West Texas with the completion of the Amerada's University No. 1-RB, Sec. 8, Block 48, University Lands Survey, about one mile south of No. 1-RA, when it flowed 520 barrels of 45.1° gravity oil in 7 hours through ½-inch choke on 2-inch tubing after acid treatment of 5,000 gallons. "Pay" was topped at 9,106 feet and the casing was perforated from 9,106 to 9,122 feet.

The pay section is a very coarse crystalline dolomite with very good interstitial porosity. The total thickness of the porous zone is about 66 feet of which about 20 feet is effective "pay."

The following stratigraphic section was drilled in the discovery well.

	Depth in Feet
Cretaceous	0–740
Triassic	–1,000
Permian	
Ochoa series	–1,410
Guadalupe series	–2,475
Leonard and Wolfcamp series undifferentiated	–8,530
Pennsylvanian undifferentiated	–8,905
"Detrital zone"	–8,961
Ellenburger (Lower Ordovician)	–9,294 T.D.

[1] Manuscript received, January 30, 1942.

[2] Research geologist, University Lands.

At the end of January, 1942, there were two producers and two drilling wells in the field. One test had been abandoned after testing porous zones in the San Andres (Leonard series). Development is expected to proceed at a rapid rate if materials are available because the Amerada holds 75 quarter-section leases which expire in June, 1943, and other companies hold 13 quarter-section leases which expire at the same time.

Discovery of the field is due primarily to geophysical exploration. Intensive work along a known northwest-trending nose mapped on the Yates sand resulted in the initial test being drilled.

Present information is not adequate for reliable conclusions regarding the structure, but it might be interpreted as a rather broad, flat anticline.

LOS ANGELES BASIN EARTHQUAKE OF OCTOBER 21, 1941, AND ITS EFFECT ON CERTAIN PRODUCING WELLS IN DOMINGUEZ FIELD, LOS ANGELES COUNTY, CALIFORNIA[1]

KENNETH M. BRAVINDER[2]
Compton, California

INTRODUCTION

The southwestern part of the Los Angeles Basin was affected by an earthquake at 10:57 P.M. on October 21, 1941. The epicenter of this shock, as located by Beno Gutenberg[3] of the Seismological Laboratory of the Carnegie Institution of Washington, was at a point along the Newport-Inglewood fault zone approximately 3 miles southeast of the center of the Dominguez oil field (Fig. 1).

This shock is of particular geologic interest because the casing in fifteen flowing wells in the western part of the field was damaged to the extent that a $1\frac{1}{2}$-inch dummy pressure bomb would not pass through the inside of the $2\frac{1}{2}$-inch tubing at the point of damage. A tabulation of information concerning the damaged wells is given in Table I.

ACKNOWLEDGMENTS

The writer wishes to thank W. S. Eggleston and Carl A. Steiner of the Union Oil Company of California and Dean Sheldon of R. E.

[1] Manuscript received, January 31, 1942.

[2] Union Oil Company of California, Post Office Box 511.

[3] Beno Gutenberg, oral communication.

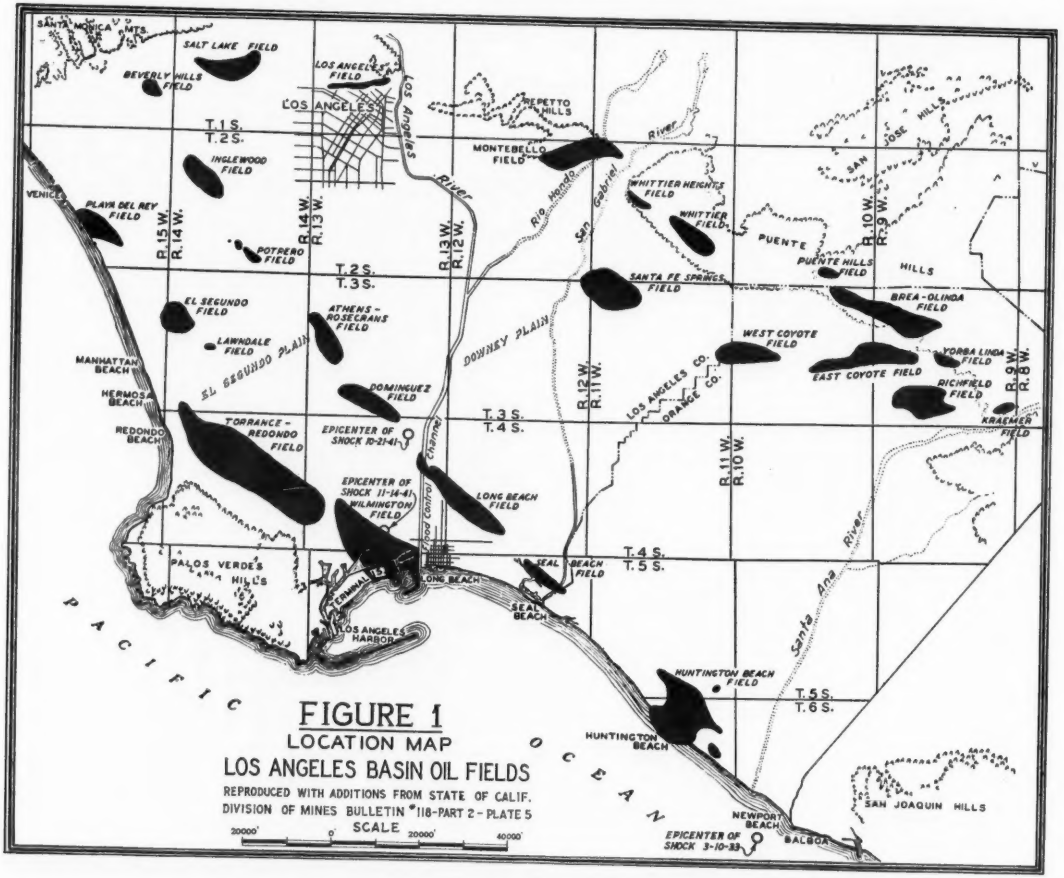


FIGURE 1
LOCATION MAP
LOS ANGELES BASIN OIL FIELDS
REPRODUCED WITH ADDITIONS FROM STATE OF CALIF.
DIVISION OF MINES BULLETIN "118-PART 2 - PLATE 5
SCALE
20000' 0 20000' 40000'

FIG. 1

Havenstrite, Operator, for their aid and constructive criticism during the preparation of this paper. Thanks are also due Beno Gutenberg of the California Institute of Technology for information concerning the epicenters of the recent earthquakes.

TABLE I

Well	Elev. (Feet)	Producing Zones	Total Depth (Feet)	Water Shut-Off Casing		Tubing Damaged at Depth (Feet)	Intersection of Plane of W-1 Fault as Determined from Electric Log (Depth, Feet)	Effect on Well Production
				Diameter (Inches)	Depth (Feet) Cemented			
UNION OIL CO. OF CALIF.								
Austin No. 1	42	7 & 8	7,480	7	6,970	5,688	—	None
Callender 56	81	8	9,620					
		Plug—	7,300	9⅝	7,158	6,130	6,160	None
Callender 68	78	7 & 8	7,395	7	6,770	6,684	—	None
Callender 70	74	7 & 8	7,355	7	6,731	6,051	6,070	None
Callender 71	78	7 & 8	7,485	7	6,880	6,739	—	Died
Callender 72	60	7 & 8	7,400	7	6,740	5,320	5,325	Died
Callender 73	62	7 & 8	7,460	7	6,980	6,307	—	Died
Callender 75	45	7 & 8	7,396	7	6,895	5,899	5,900	Died temporarily
Callender 76	64	7 & 8	7,565	7	7,075	6,784	—	None
Callender 78	49	7 & 8	7,375	7	6,830	6,021	6,012	Died
Callender 80	70	7 & 8	7,414	5½	Perf. 7,202	5,385	5,380	Died
R. E. HAVENSTRITE, OPERATOR								
Larronde No. 1	42	7 & 8	7,543					
		Plug—	7,500	7	6,972	6,133	—	Prod. temporarily declined
Larronde 2	50	7 & 8	7,587	7	7,043	6,428	—	Prod. temporarily declined
Larronde 3	31	7 & 8	7,542	7	7,015	5,600	—	Died
Larronde 4	35	7 & 8	7,635	7	7,630	6,236	—	Died

GENERAL GEOLOGY OF DOMINGUEZ OIL FIELD

The Dominguez oil field occupies one of a series of *en échelon* anticlinal folds along the Newport-Inglewood fault zone, one of the most prominent structural features traversing the Los Angeles Basin. At present the field has eight producing zones designated as the First to Eighth Callender zones, respectively, lying between depths of 3,900 feet and 7,500 feet on top of the structure. The upper five zones are within the Repetto (Pliocene) formation, the lower three within the Puente (Miocene).

Structurally the field is an anticline modified by two well developed systems of faulting: (1) a series of generally high-angle normal and reverse faults striking oblique to the axial trend and (2) a series of south-dipping reverse faults striking nearly parallel with the axial trend. The faults of the first series divide the field into four main structural blocks (Fig. 2). The members of the second series increase in number and amount of throw with depth, but die out as they are traced upward in the section. Faulting has been important in the control of the accumulation of oil within the structure, particularly in the Miocene zones.

RELATION OF AREA OF DAMAGE TO STRUCTURE

The damaged wells are located in an elliptical area with a trend of N. 60° E., lying in the westerly of the four main structural blocks of the field. On this block only the Seventh and Eighth Callender zones are productive. The fifteen damaged wells may be divided into two groups. In a southerly group of nine wells the point of damage occurs at seemingly unrelated depths between 5,600 feet and 6,784 feet. No faults were known to intersect the bore of these wells. In a northerly group of six wells the point of damage occurs between 5,320 feet and 6,130 feet at, or close to, the intersection of the well bore with the plane of a south-dipping reverse fault designated as W-1 in Figure 2 and in Figures 3, 4, and 5. All of the wells in the field intersected by the W-1 fault were damaged by the earthquake. Other wells in the vicinity of those known to be damaged were checked through the tubing and no evidence of damage was found. It is interesting to note that no evidence of damage was found at the point of intersection of faults W-2 and W-5 a short distance north of W-1.

INFORMATION OBTAINED DURING PROGRESS OF WELL REPAIR

Of the damaged wells, repair work has been started on Union Oil Company of California's Callender 72, 73, 78, and 80, and R. E. Havenstrite's Larronde No. 4. In each case the initial step was to fill the hole with mud and attempt to establish circulation. In Union Oil Company of California's Callender 72, 73, and 78, and R. E. Havenstrite's Larronde No. 4, it was found that the casing was sufficiently damaged to allow the entry of salt water.

The second step was an attempt to remove the tubing from the well. In only one case, Callender No. 72, was the tubing found to be sheared. In the other wells the tubing could not be worked loose and it was necessary to cut and pull it from above the point of damage.

In Callender No. 72 the tubing was completely sheared at a depth of 5,320 feet. The break was sharp as shown in Figure 6. In this well the point of shear was at the intersection of the plane of the W-1 fault. Subsequent to the removal of the tubing, a $6\frac{1}{8}$-inch Zublin bit was run inside of the 7-inch casing past the point of tubing shear, and 14 feet of hole was drilled without encountering any iron. This indicates that the lateral component of movement along the W-1 fault at this point was more than 7 inches.

As shown on the accompanying cross sections (Figs. 3, 4, and 5), it may be seen that the W-1 fault has a progressively lower dip as it is traced upward in section and a diminishing amount of throw as it is traced westward along its strike. It is terminated on the east by the

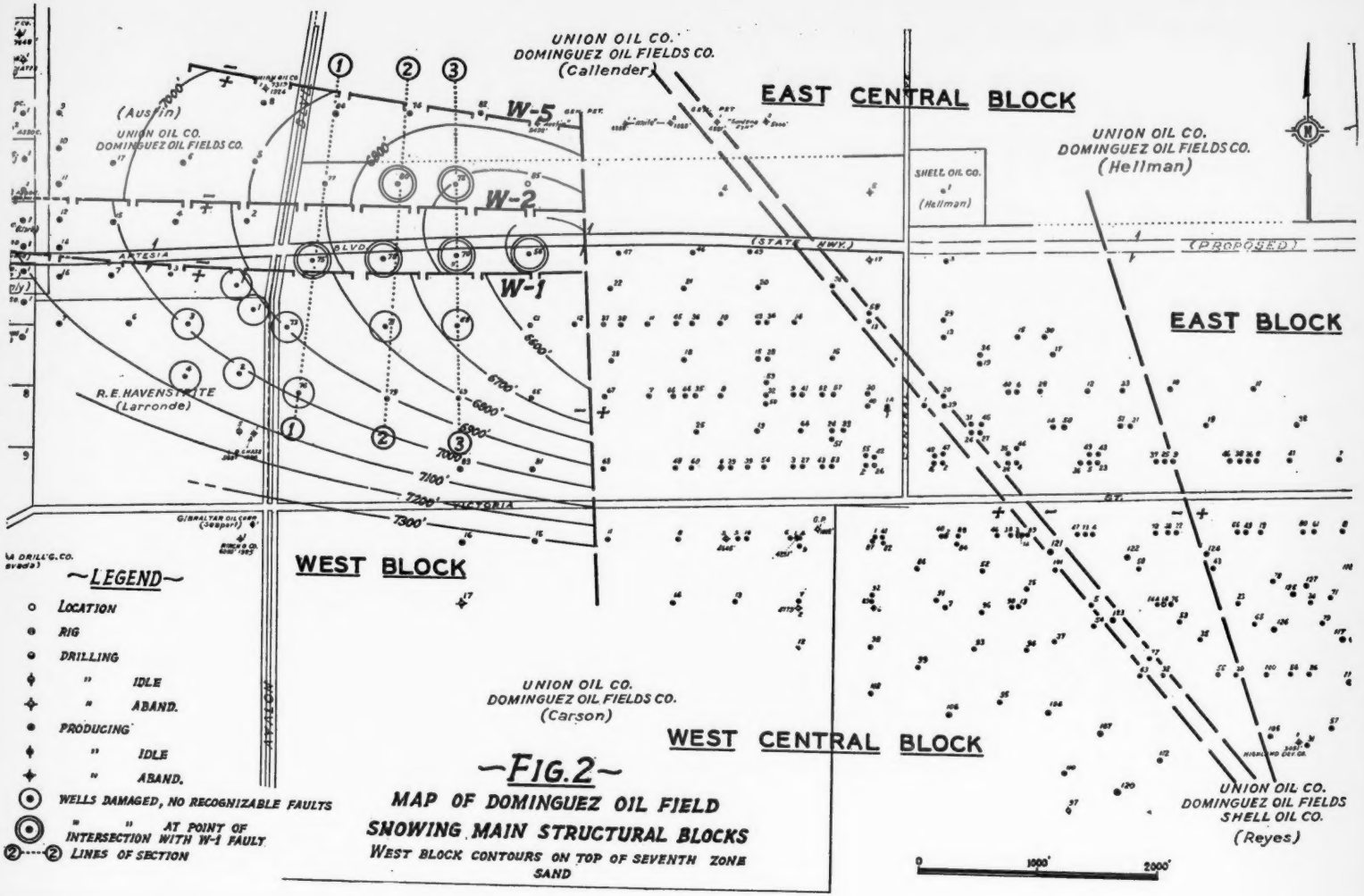
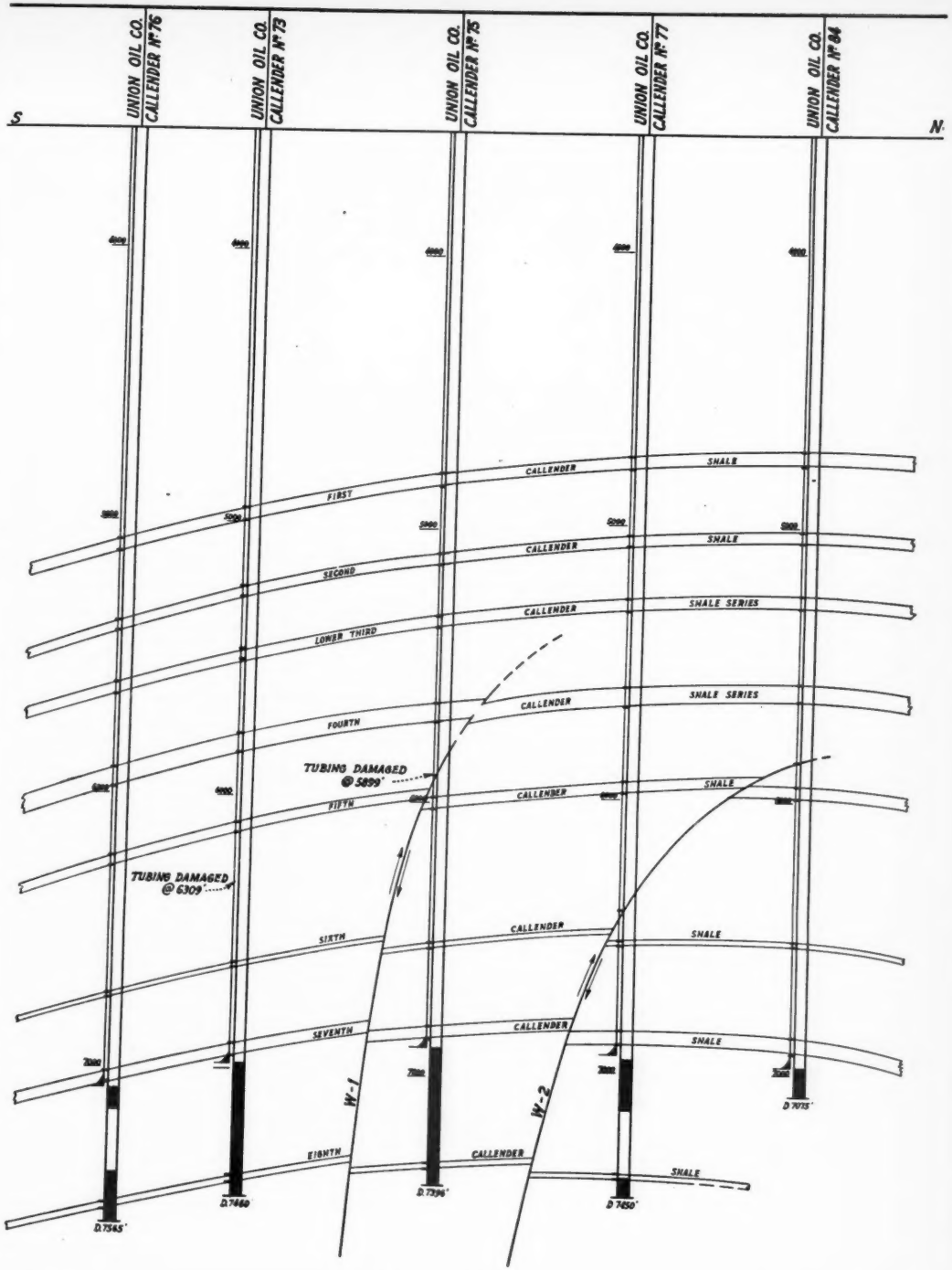

UNION OIL CO.
DOMINGUEZ OIL FIELDS CO.
(Callender)
EAST CENTRAL BLOCK
(Austin)
UNION OIL CO.
DOMINGUEZ OIL FIELDS CO.
W-5
W-2
W-1
UNION OIL CO.
DOMINGUEZ OIL FIELDS CO.
(Hellman)
SHELL OIL CO.
(Hellman)
(STATE HWY.)
(PROPOSED)
EAST BLOCK
ARTESIA BLVD.
R. E. HAVENSTRITE
(Larronde)
6600'
6700'
6800'
6900'
7000'
7100'
7200'
7300'
ARTESIA
WEST BLOCK
UNION OIL CO.
DOMINGUEZ OIL FIELDS CO.
(Carson)
WEST CENTRAL BLOCK
UNION OIL CO.
DOMINGUEZ OIL FIELDS
SHELL OIL CO.
(Reyes)
AVALON
0
1000'
2000'
~LEGEND~
LOCATION
RIG
DRILLING
" IDLE
" ABAND.
PRODUCING
" IDLE
" ABAND.
WELLS DAMAGED, NO RECOGNIZABLE FAULTS
" " AT POINT OF INTERSECTION WITH W-1 FAULT
LINES OF SECTION
~FIG. 2~
MAP OF DOMINGUEZ OIL FIELD
SHOWING MAIN STRUCTURAL BLOCKS
WEST BLOCK CONTOURS ON TOP OF SEVENTH ZONE SAND

FIG. 2

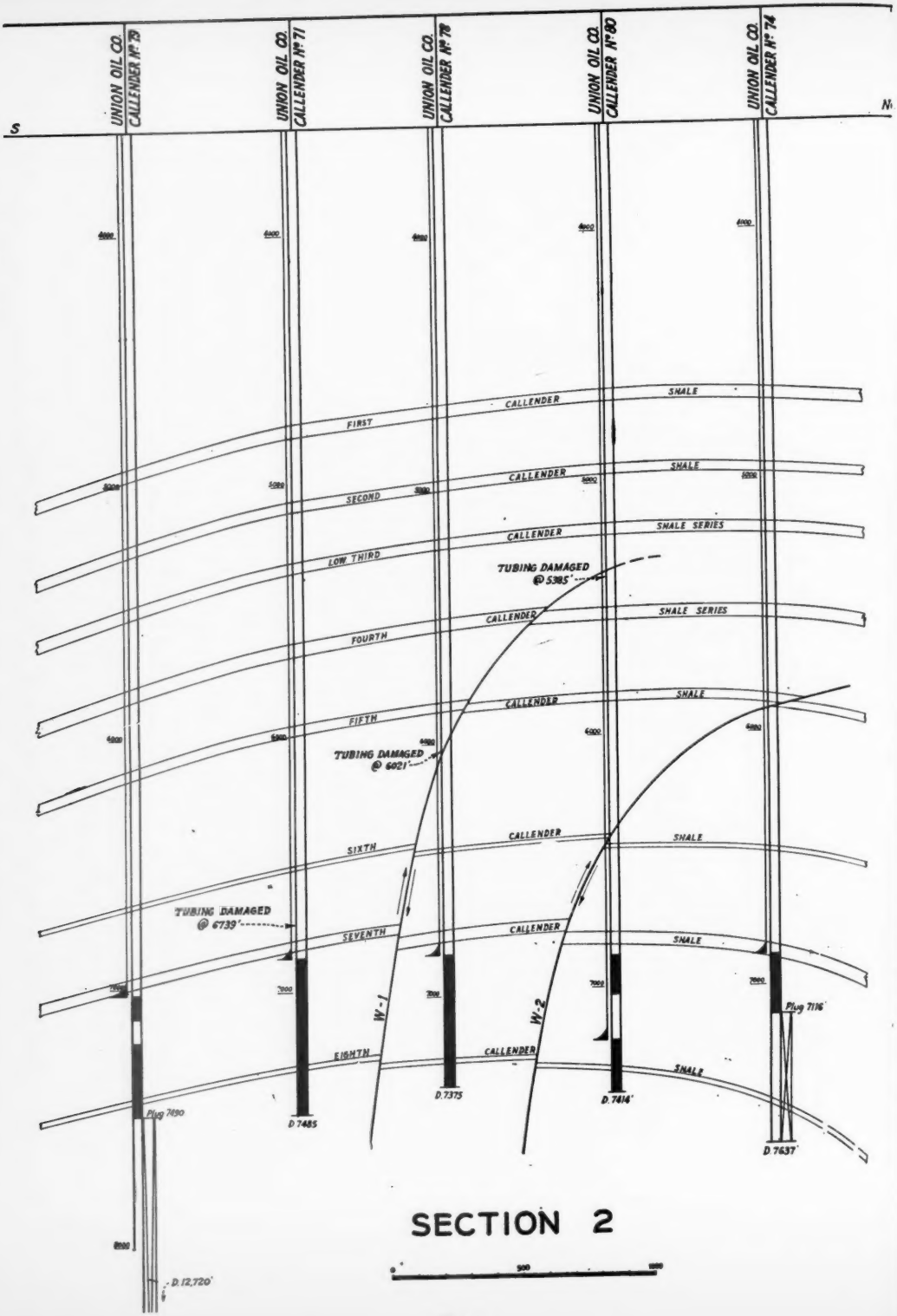


SECTION 1

0 200 400

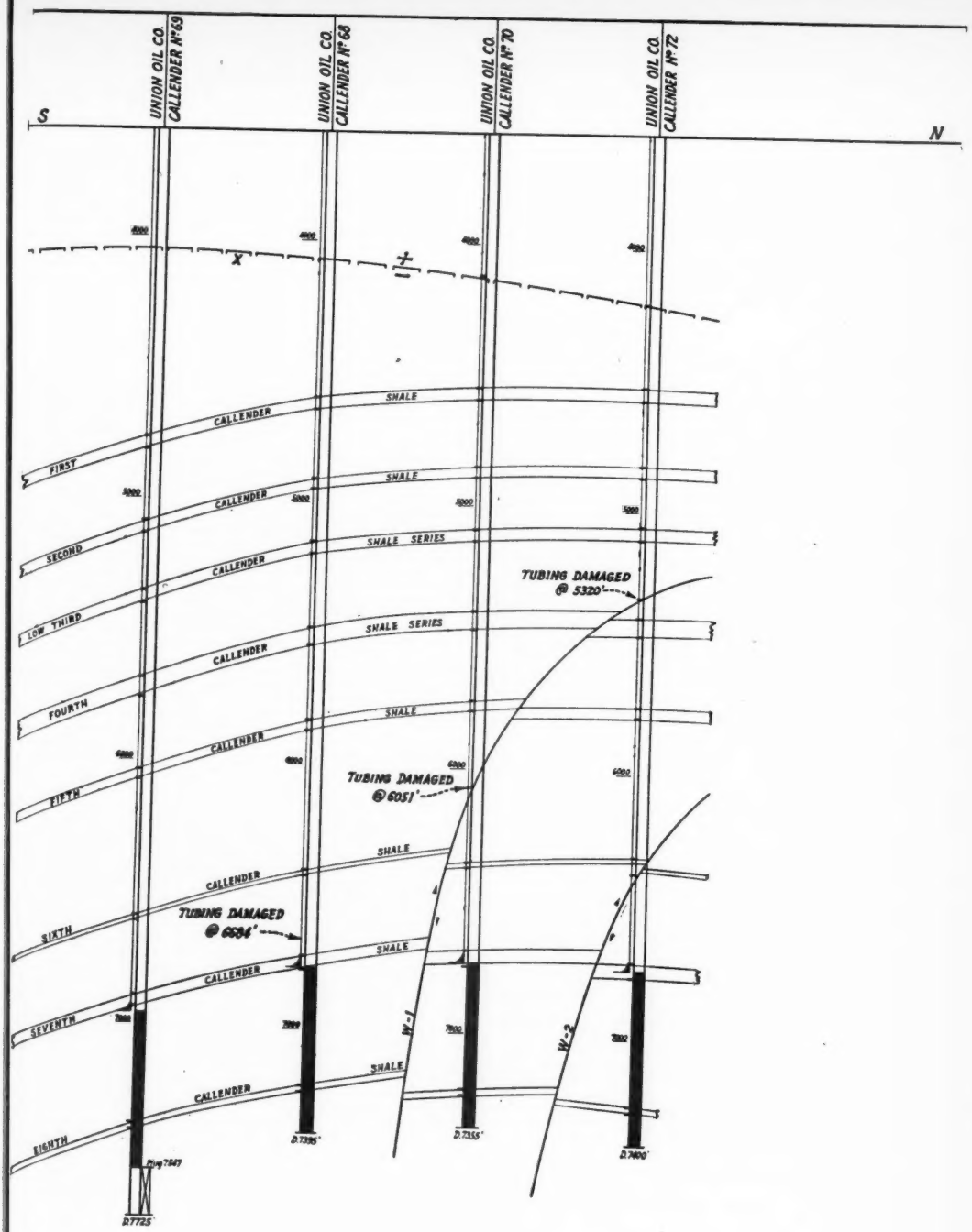
FIG. 3

FIG. 2



SECTION 2

FIG. 4



SECTION 3

FIG. 5

fault that forms the east boundary of the west block. It is therefore probable that the lateral component of movement along the W-1 fault was greater at the location of Callender No. 72 than in any other well. The angle of dip of the fault plane is so high at the point of intersection in the next line of wells on the south that the horizontal compo-



FIG. 6.—Photograph of completely sheared 2.5-inch tubing recovered from Union Oil Company of California's Callender well No. 72.

nent of movement was probably relatively small. It is almost certain that had a well been drilled at the undrilled location north of Callender No. 56 it would have been badly damaged by the earthquake.

At the present time, Callender No. 80 has been recompleted. In this well the remedial work consisted of recovering the $2\frac{1}{2}$-inch tubing to 7,375 feet and the squeezing away of 97 sacks of cement under 2,300 pounds pressure with a cementing tool set at 5,340 feet. The $5\frac{1}{2}$-inch casing was then cut and pulled from 5,261 feet. A second cement plug of 100 sacks of cement mixed with 25 sacks of sand was then pumped in through drill pipe hung at 5,260 feet. The top of the cement was located at 5,090 feet and drilled out to 5,120 feet. A whipstock was set and the well directionally redrilled. The well was recompleted in approximately the same producing interval on Decem-

ber 17, 1941, with an initial production of 1,383 barrels daily of 30.4° A.P.I. gravity oil, 2.4 per cent cut, with a 56/64-inch bean, 220 pounds tubing pressure, 400–530 pounds casing pressure, and 2,158,000 cubic feet of gas. The initial production on the original completion, November 23, 1940, was 588 barrels daily, 30.4° A.P.I. gravity, 1.2 per cent cut, with a 36/64-inch bean, 370 pounds tubing pressure, 675 pounds casing pressure and 673,000 cubic feet of gas.

STRUCTURAL HISTORY OF DOMINGUEZ OIL FIELD

In considering the damage caused by the earthquake, the points of primary interest are (1) the reason for the localization of the damage within a particular area and (2) the possibility of a recurrence of such an economically undesirable phenomenon. The answers appear to be related to the mode of origin and youthful age of the Dominguez structure.

MODE OF ORIGIN

The mode of origin of the fields of the Newport-Inglewood structural line has been discussed by Ferguson and Willis,[4] by Eaton,[5,6] and more recently summarized and enlarged upon by Reed and Hollister.[7] These authors advance the hypothesis that the fields of the Newport-Inglewood line are on a series of *en échelon* anticlinal folds formed as the result of horizontal shearing movements between blocks of the underlying basement. Concerning this hypothesis, Reed and Hollister[8] state:

> If this hypothesis is adopted, the conclusion follows that the Newport-Inglewood anticline follows a basement boundary of the kind that has elsewhere been the locus of important movements during the Tertiary and perhaps longer. The surface anticline may thus be considered to overlie a basement fault. Pursuing the hypothesis farther, we may even infer the direction and degree of dip of this hypothetical fault. On these problems there are, in fact, two types of evidence, both, of course, delightfully speculative. First, if the fault is correctly inferred to be a fracture along a boundary which is a southward continuation of the slate-granite boundary of the Santa Monica Mountains, it may be expected to dip in the same direction as that contact, which is southwest. Second, the seismologic evidence suggests the same

[4] R. N. Ferguson and C. G. Willis, "Dynamics of Oil-Field Structure in Southern California," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 8, No. 5 (September–October, 1924), pp. 576–83.

[5] J. E. Eaton, "A Contribution to the Geology of Los Angeles Basin, California," *ibid.*, Vol. 10, No. 8 (August, 1926), pp. 753–67.

[6] ———, "Long Beach Earthquake of March 10, 1933," *ibid.*, Vol. 17, No. 6 (June, 1933), pp. 732–38.

[7] R. D. Reed and J. S. Hollister, *Structural Evolution of Southern California* (Amer. Assoc. Petrol. Geol., 1936), pp. 112–35.

[8] R. D. Reed and J. S. Hollister, *op. cit.*, pp. 132–33.

conclusion since, as previously noted, the epicenter of the Long Beach earthquake was determined as lying a short distance to the southwest of the surface manifestation of the structural belt. If the focus was at a depth of approximately ten miles, moreover, as is considered seismologically possible, the dip of the fault plane may be computed as approximately 75 degrees.

By way of summary, and of returning to earth from the speculative flight of the preceding paragraph, it may be said that in the blanket of Upper Miocene and later strata the Newport-Inglewood structure is a domed, slightly faulted anticline; at a depth of several thousand feet it may be a granite-Franciscan contact that has been a locus of movement since the Middle Miocene and perhaps much longer. The more recent disturbances may have involved a slight shearing tendency which puckered the strata into small domes and fractured them with minor *en échelon* faults. The belt separates the western part of the Los Angeles Basin, which is topographically the El Segundo Plain and structurally a part of the Catalina uplift, from the eastern part, which is topographically the Downey Plain and structurally the landward apex of the Capistrano Tertiary embayment.

Since the foregoing was written, additional evidence has been obtained tending to confirm this hypothesis concerning the mode of formation of the Dominguez structure. First, a detailed study of the subsurface geology of the Dominguez field has yielded evidence to prove horizontal movement along the series of faults striking oblique to the axial trend of the structure. Second, the drilling of Union Oil Company of California's Callender No. 79 in the western part of the field in 1940–41 proved the existence of the Franciscan schist basement beneath the western part of the field. This well was drilled to a depth of 12,720 feet and encountered the top of the schist at 12,415 feet. This is of particular interest because it is the closest point to the Newport-Inglewood fault zone in this part of the basin under which the presence of the Franciscan basement has been proved.

AGE OF DOMINGUEZ STRUCTURE

The youthful topography of the Dominguez field has been discussed by Reed[9] as follows.

> The most striking feature of the Dominguez anticline is that its site is marked by a low rounded hill, elliptical in plan. With a slight amount of "restoration," especially where the east end has been cut away by the Los Angeles River, the topographic contours of the hill reflect in a slightly subdued manner the structural contours drawn on top of one of the oil sands. The arched surface of the hill is therefore considered to be a "tectonic" surface, and to have been warped upward by the forces that caused the fold. These forces have acted so recently that, unlike the surface at Kettleman Hills, the "Dominguez surface" has been little affected by erosion. According to all indications, the beds immediately underlying this surface are geologically very young.

[9] R. D. Reed, *Geology of California* (Amer. Assoc. Petrol. Geol., 1933), p. 47.

At Long Beach, fortunately, the conditions are such that the Dominguez surface can be accurately dated with respect to the geological column of southern California. In the Long Beach anticline, a few miles southeast of Dominguez Hill, the Dominguez surface is interrupted by two small hills (Signal Hill and another) which rise above it along the anticlinal axis. They are obviously unreduced remnants belonging to an earlier stage. Examination of the folded strata exposed in them reveals the presence of large numbers of marine fossils. These have been studied by several paleontologists all of whom agree that they are younger than the Lower San Pedro stage of the Pleistocene. They are in fact nearly identical with, but possibly slightly older than, the Upper San Pedro fauna commonly found in beds covering the youngest marine terraces along the southern California coast. This correlation dates the final arching of the Dominguez surface of post-Lower San Pedro and perhaps post-Upper San Pedro—very late Pleistocene if not younger.

LOCALIZATION OF AREA OF DAMAGE

The foregoing evidence, together with the periodic occurrence of earthquakes along the Newport-Inglewood line, indicates that the Dominguez structure is still growing, probably as a result of continued lateral movement along the Newport-Inglewood line of shear. In this process of continued growth, areas of unrelieved stress are continually being formed. It thus appears that, previous to the earthquake of October 21, 1941, unrelieved stresses were present near the crest of the structure on the west block of the Dominguez field. These were relieved as a secondary effect of the earthquake whose epicenter was on the Newport-Inglewood fault zone several miles southeast. Because of the localization of the stresses, the relief and consequent damage to the wells were by movement along the W-1 fault and possible planes of incipient faulting lying south of the W-1 fault.

POSSIBILITY OF FURTHER DAMAGE

The possibility of further damage to wells in this area within their producing life is particularly important from an economic standpoint. If it is accepted that the destruction was the result of a sudden release of stresses that had been gradually built up by the continued growth of the structure, it seems improbable that there will be a recurrence within the productive life of the wells. The fact that the more recent and slightly more intense earthquake of November 14, 1941, the epicenter of which was approximately 4 miles south of the one of October 21,[10] did not cause any recognizable damage corroborates this hypothesis. It thus appears that at the present time the stresses have been relieved and, therefore, the possibility of further damage by earthquakes of moderate intensity is remote.

[10] Beno Gutenberg, written communication, November 28, 1941.

PATTERSON POOL, KEARNY COUNTY, KANSAS[1]

M. D. HUBLEY[2]
Garden City, Kansas

A new oil-producing area in southwestern Kansas was discovered in August, 1941, by the Stanolind Oil and Gas Company, in T. 22 S., R. 38 W., Kearny County. The discovery well, the Patterson No. 1, center of E. ½, SE. ¼, SE. ¼ of Sec. 23, T. 22 S., R. 38 W., encountered oil in a Pennsylvanian sand from the depth 4,740 feet to 4,752 feet in the Cherokee group of strata. A 20-minute drill-stem test of the sand body resulted in a fill-up of 1,855 feet of oil and 185 feet of drilling fluid. On completion, with the bottom-hole pressure measuring 1,128 pounds, the well was assigned a pumping depthograph-indicated capacity of 3,964 barrels of oil per day. The gravity of the oil is 34° Bé., corrected. The oil-producing sand has been named the Patterson sand, and the producing area designated the Patterson pool.

The Patterson pool discovery well was the third test drilled by the Stanolind Oil and Gas Company in northwestern Kearny County. Located 7 miles northwest of the present discovery, the first test in the area was the Judd No. 1, drilled in Sec. 15, T. 21 S., R. 38 W. This test was abandoned in granite at a total depth of 6,071 feet after testing showings of oil found in several zones including the Topeka, Lansing, Cherokee, and a sandy zone just above the top of the Mississippian. The second test, the Bellinger No. 1, was drilled in Sec. 15, T. 21 S., R. 38 W., approximately ½ mile west of the Judd No. 1. At the total depth of 5,155 feet, in Mississippian limestone, the Bellinger No. 1 was abandoned after having encountered essentially the same oil showings and structural conditions as in the Judd No. 1.

The list at the top of next page, showing the depths at which some of the geological markers were logged, affords a comparison between conditions in the vicinity of the Judd test and the structurally lower area of the Patterson pool.

As indicated in the table, the Patterson No. 1 was drilled to the total depth of 5,690 feet, penetrating 35 feet into the Arbuckle dolomite before being plugged back and completed in the Patterson sand. No other showings of oil were observed in the drilling of the well.

Field development to January 1, 1942, includes one additional oil well, one failure, and one drilling operation, the north offset to the Patterson No. 1.

[1] Published by permission of Stanolind Oil and Gas Company. Manuscript received, February 5, 1942.

[2] Geologist, Stanolind Oil and Gas Company.

	Stanolind Oil and Gas Co. Judd No. 1, C. SE. ¼, SE. ¼ Sec. 15, T. 21 S., R. 38 W. Elevation, 3,347 feet	Stanolind Oil and Gas Co. Patterson No. 1, C. E. ½, SE. ¼, SE. ¼ Sec. 23, T. 22 S., R. 38 W. Elevation, 3,322 feet
Formation	*Depths in feet below surface*	*Depths in feet below surface*
Cretaceous	210	250
Dakota	530	450
Permian	960	880
Blain gypsum	1,390	1,350
Anhydrite (Stone Corral)	2,170	2,127
Topeka	3,665	3,680
Lansing	4,060	4,100
Cherokee	4,390	4,420
Patterson sand	Absent	4,740–4,752
Mississippian	4,811	4,879
Viola	5,425	5,536
Arbuckle	5,555	5,655
Granite	6,065	—
Total depth	6,071	5,690

The Gropp No. 1, east offset to the discovery well, was given on completion a physical potential rating of 461 barrels of oil per day. This well has the same thickness (12 feet) of Patterson sand, and is correlated 4 feet lower than the discovery well.

In the test offsetting the Patterson No. 1 on the south, coring indicated the top of the Patterson sand to be 6 feet higher structurally than in the Patterson No. 1. However, after casing had been run and the well deepened with cable tools, the Patterson sand was found to be missing and the interval was dark shale and siltstone. No oil was obtained from the thin remnant of sand at the top of the zone.

With exception of the sandy phase at the contact (unconformity) of the Cherokee and Mississippian strata, the Patterson sand is the only sand body logged in the Cherokee section of the wells in the Patterson pool. In texture the Patterson sand is not uniform. Included are a few thin streaks of silty, fine-grained, shale-streaked sandstone interbedded with and intermixed with the predominant layers of large to coarse subangular-grained porous sandstone. Several fine gravelly streaks having good porosity are present. Thin seams of lignitic coal occur near the top of the sand.

The discovery of oil in Kearny County is significant because of the extension of production 23 miles westward in Kansas to a point within 33 miles of the Colorado border. Also, the Cherokee group of sediments has been added to the zones known to be "reservoir rocks" in western Kansas.

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VOL. 26, NO. 3 (MARCH 1942), PP. 402-409, 3 FIGS.

DISCUSSION

ARTINSKIAN SERIES[1]

CARL O. DUNBAR[2]
New Haven, Connecticut

Most attempts to locate the natural base of the Permian system have been strongly influenced by the stratigraphic interpretation given to the Artinskian deposits.

These were briefly described by Murchison as the "grits of Artinsk,"[3] and later were critically studied by Karpinsky, who made them the basis of his Artinskian stage.[4] Although the name was derived from the town of Artinsk in the middle Urals, the type section was designated to be in the Orenburg district in the southern Urals[5] over 300 miles down the strike. In this early work the name Artinskian was applied to a detrital facies, a great series of shales, siltstones, sandstones, and conglomerates that form a relatively narrow belt along the western flank of the Urals.

These detrital formations were originally referred to the Carboniferous, the lower limit of the Permian being drawn by Murchison at the base of the Kungurian. This assignment was generally accepted until 1889 when, as a result of his monographic study of the ammonites, Karpinsky[6] concluded that the Artinskian belongs with the Permian rather than the Carboniferous. Since that date the Permian age of the Artinskian detritals has been generally accepted, both in Russia and abroad.

In the original publication in which Karpinsky proposed the Artinskian stage and described its type section, he referred to a basal calcareous unit as the Sakmarian limestone.[7] After he had transferred the Artinskian to the Permian, some students of the problem evidently thought that he may not have intended to include the Sakmarian in this shift, for in 1891 he returned to the problem and concluded, "Thus I must declare that I have never established a two-fold division of the Ural Carboniferous-Permian strata into Artinskian and Sakmarian stages. I have established only one, the Artinskian stage, which I regard as completely developed in the basin of the River Sakmara."[8]

[1] Manuscript received, January 19, 1942.

[2] Professor of paleontology and stratigraphy, Yale University.

[3] R. I. Murchison, Eduard de Verneuil, and Alexander von Keyserling, *The Geology of Russia in Europe and the Ural Mountains*, London (1845), Vol. 1, pp. 129, 354, 449.

[4] A. Karpinsky, "Geologische Untersuchungen im Gouvernment Orenburg," *Verh. Min. Gesellsch.* (St. Petersbourg), Vol. IX (1874), pp. 212–310.

[5] *Op. cit.*, p. 267.

[6] A. Karpinsky, "Ueber die Ammoneen der Artinsk-Stufe," *Mem. Acad. Sci.* (St. Petersbourg), 7th Ser., Vol. 37, No. 2 (1889).

[7] *Op. cit.*, p. 268, footnote.

[8] A. Karpinsky, "On the Ammonites of the Artinskian Stage," *Verh. Min. Gesellsch.* (St. Petersbourg), Vol. 27 (1891), p. 194, footnote.
For this observation, as well as that of the preceding footnote, I am indebted to

However, in the course of a recent critical and extended restudy of the stratigraphy of the Orenburg region, Ruženčev[9] has separated the Sakmarian and elevated it to the rank of a stage [or series] characterized by faunas of the *Pseudoschwagerina* complex. He showed, moreover, that, whereas it is a limestone in the western part of the Orenburg district, it passes eastward into detrital sediments resembling the Artinskian and attaining a thickness of approximately 3,000 feet. In view of the fact that the zone of *Pseudoschwagerina* is a key zone, recognizable in many parts of the world and much involved in discussions concerning the Pennsylvanian-Permian boundary, this move by Ruženčev seems particularly appropriate. In the following discussion, we therefore follow Ruženčev in limiting the Artinskian in its type section to the beds between the Sakmarian (the zone of *Pseudoschwagerina*) and the Kungurian. It is worthy of emphasis, however, that the Sakmarian was originally included in the Artinskian by Karpinsky and deliberately placed with the latter in the Permian.

West of the belt of Artinskian detritals lies the Ufa Plateau in which the interval between the Sakmarian and the Kungurian is occupied by a great series of limestones (Fig. 2). These also were observed by Murchison and referred by him to the Carboniferous. They are richly fossiliferous but have yielded only a few ammonites and were not critically considered by Karpinsky when he shifted the base of the Permian down to include the Artinskian. Tschernyschew followed the traditional view and assumed a Carboniferous age for these limestones, and the influence of his great monograph, "Die Oberkarbonischen Brachiopoden des Ural und des Timan,"[10] did much to perpetuate this belief.

But with growing appreciation of changes of facies, several of the Soviet geologists, notably Noinsky, Nalivkin, Ossipov, Gerassimov, and Ruženčev, came to the belief that the limestones in the longitude of the Ufa Plateau are merely the calcareous facies of the Artinskian series. During the discussions of the Seventeenth International Geological Congress, it was evident that two schools of thought still exist among the Soviet geologists, one adhering to the traditional view that the limestones of the Ufa Plateau are older than the Artinskian detritals and are Carboniferous, the other believing that they are merely a calcareous facies of the Artinskian.

I adopted the latter interpretation in my recent review of the stratigraphy of the type region of the Permian.[11] This view has recently been criticized

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Siemon Muller and to C. W. Tomlinson. Muller encountered these statements while reading the original text in Russian, which is somewhat fuller than the German version. The foregoing quotation is a free translation by Muller from the Russian. Muller communicated this information to Tomlinson who in turn passed it on to me. I am grateful to both gentlemen for their permission to use it.

[9] V. E. Ruženčev, "New Data on the Stratigraphy of the Carboniferous and Lower Permian of the Orenburg and Aktioubinsk Districts," *Problems of Soviet Geology*, No. 6 (1936), pp. 470–506. Also, "Ammonoids of the Sakmarian Stage and Their Stratigraphic Significance," *Prob. of Paleontology* (Pal. Lab. Univ. of Moscow), Vol. IV (1938), pp. 187–285.

[10] *Mém. Com. Géol.*, Vol. 16 (1902), Tome 1, Text, pp. iii–viii, 1–749; Tome 2, Atlas, Pls. I–LXIII.

[11] Carl O. Dunbar, "The Type Permian: Its Classification and Correlation," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 2 (February, 1940), pp. 237–81.

by Kay,[12] who advocates a return to the view of Tscherynschew.

The profound difference in these interpretations is suggested by a comparison of the two idealized sections in Figure 1. The problem is both difficult and important, and much more fact finding and analysis may be needed before it is solved to the satisfaction of all. Kay's discussion would, therefore, be greatly welcomed if it did not, unfortunately, involve misconceptions that confuse rather than clarify the relations. The following paragraphs are written in the hope of clearing up this confusion.

Kay's reason for believing that the limestones of the plateau are older than the Artinskian detritals appears to hinge on a single fact, namely, that Tolstikhina reported the presence of limestone pebbles containing *Schwagerina lutugini* in the "Lower Artinskian conglomerates" east of Buloga. He assumes that this fusuline is "the characteristic fossil of the highest limestones of the plateau,"[13] and argues that its presence in the Artinskian pebbles proves that the youngest limestones of the plateau were being eroded early in Artinskian time and therefore must be older than the Artinskian. This point requires more critical examination.

First of all, the identity of the fusuline in the pebbles is at least subject to question. It was merely mentioned by Tolstikhina in a footnote without illustration or other documentation and without authority for the identification.[14] It is certainly a tenuous basis for Kay's far-reaching conclusions.

In the second place, granting that the identification is correct, as it may well be, *Schwagerina lutugini* is by no means confined to "the highest limestones of the plateau." No complete columnar section is exposed in the Ufa Plateau, but the limestone sequence has been fully worked out in the Sterlitamak oil field south of Ufa where the cores of some 70 wells have been critically studied by Rauser-Chernoussova and a succession of fusuline zones is well established. Members of the Permian excursion visited the site of one of these wells, No. 750, near Shikhan Tra-Tau. A log of the core was presented in the *Guidebook*[15] and the succession was discussed in the field. This log, shown graphically in Figure 2, is particularly important because it includes both Sakmarian and Kungurian beds which fix definite top and bottom limits to the limestone series under discussion. The thickness of these limestones is approximately 2,700 feet (816 meters). In this section, *Schwagerina lutugini* is limited to zone 7, which lies about 860 feet (260 meters) above the Sakmarian and 1,500 feet (456 meters) below the base of the Kungurian. Here, then, instead of characterizing the "highest limestones of the plateau," it is confined to a zone well below the middle.

In the third place, it is not necessary to assume that the limestone pebbles came from the Ufa Plateau. In the very paragraph in which Tolstikhina mentioned these pebbles, she noted that other pebbles are composed of materials derived from the underlying "Lower Artinskian arenaceous-shale

[12] G. Marshall Kay, "Classification of the Artinskian Series in Russia." *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 25, No. 7 (July, 1941), pp. 1396–1404.

[13] *Op. cit.*, p. 1397.

[14] M. M. Tolstikhina, "Kuzino to Perm," *Guidebook, Permian Excursion, Northern Part, Seventeenth Internat. Geol. Congress* (1937), p. 38.

[15] M. F. Mikriukov, "The Shikhans of Sterlitamak," *Guidebook, Permian Excursion, Southern Part, Seventeenth Intern. Geol. Congress* (1937), pp. 88–89.

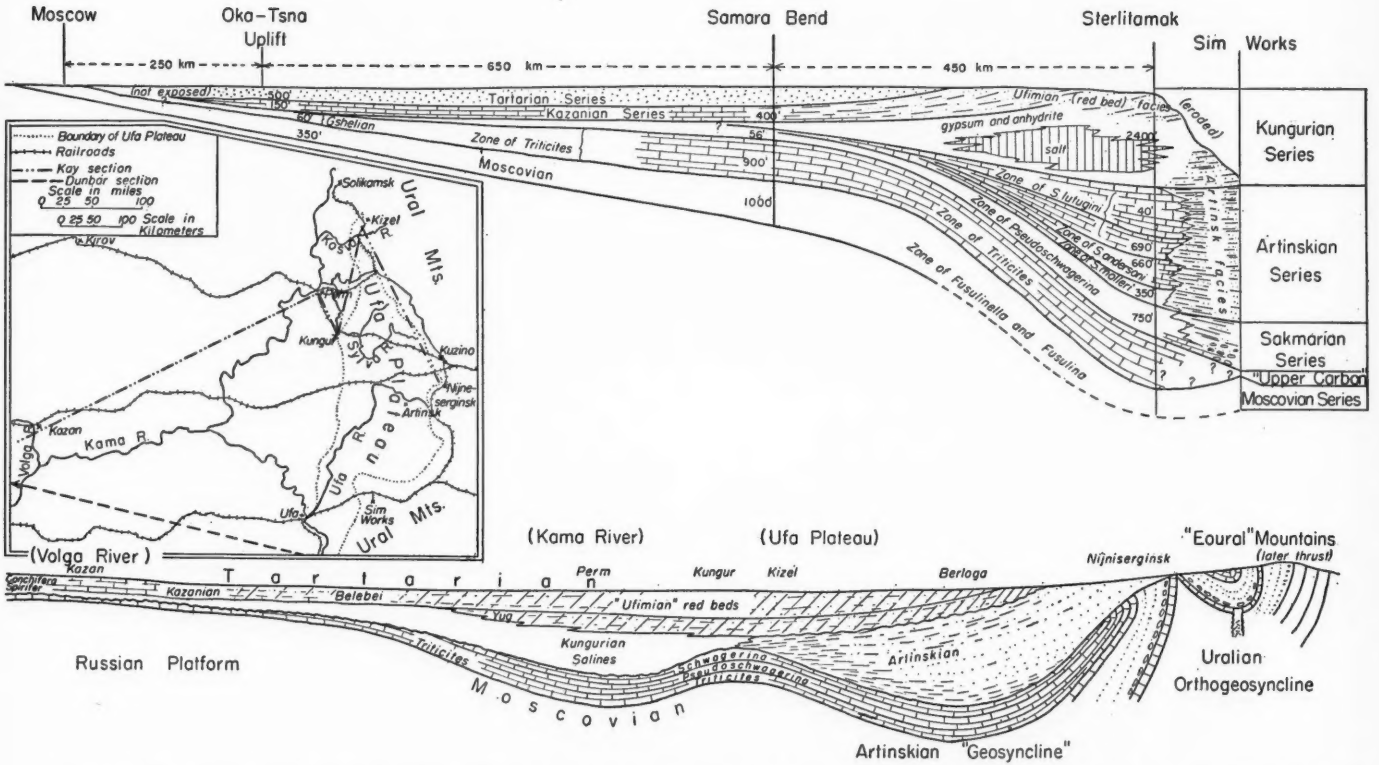


FIG. 1.—Above, idealized section across Permian basin west of Urals, after Dunbar, showing Artinskian detritals as facies intertonguing with limestones of Ufa Plateau; below, idealized section, after Kay, representing Artinskian detritals as wholly younger than limestones of Ufa Plateau. Inset map shows geographic relations. Note that Dunbar's section extends much farther west than Kay's.

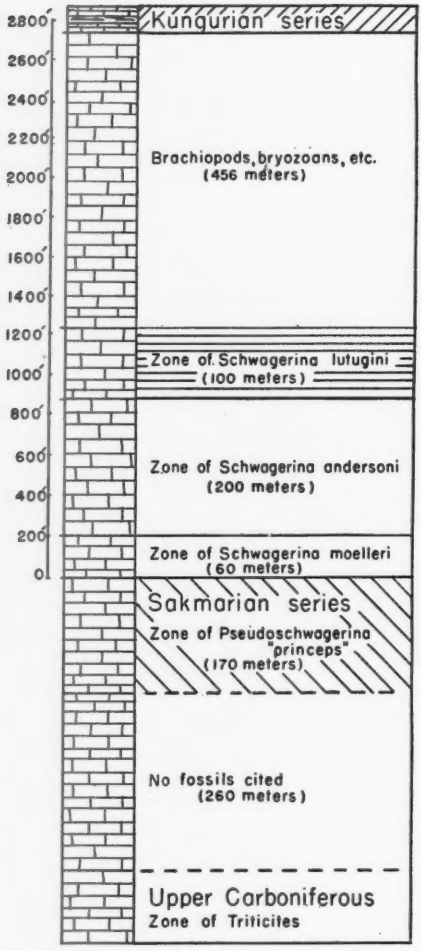


FIG. 2.—Columnar section of well No. 750 in Sterlitamak oil field. Drawn from data given by Mikriukov.

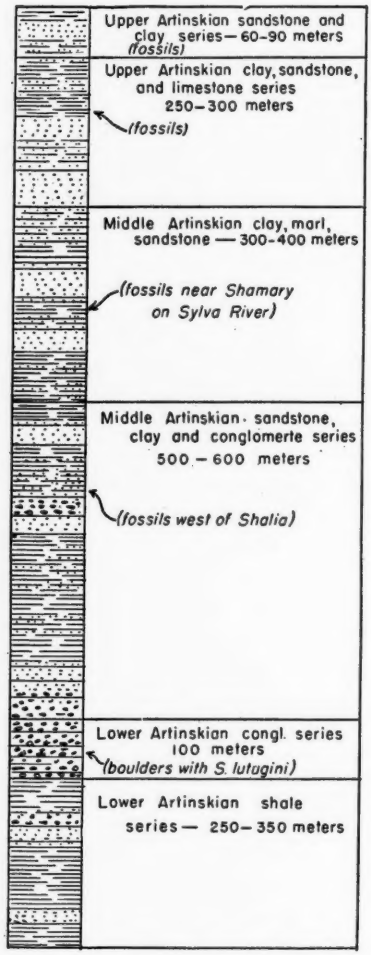


FIG. 3.—Columnar section of Artinskian beds between Kungur and Kuzino stations. Adapted from Kay's Figure 2A, based on data from Tolstikhina.

series."[16] The presence of such coarse material suggests local disturbance and erosion. At Sim Works, members of the Permian excursion saw clear evidence of locally derived coarse breccia. The fusuline-bearing pebbles near Buloga may represent merely a calcareous bed in the detrital facies that was locally disturbed and eroded after deposition.

Finally, this single species of fusuline must be weighed against the faunas cited by Tolstikhina in fossiliferous zones (not pebbles) in the "Middle Artinskian beds" which directly succeed the "Lower Artinskian conglomerates." Kay admits that "There is compelling evidence that there are clastics of 'Artinskian' facies in the Urals that are equivalent to limestones of the plateau,"[17] but argues that in the section east of Kungur, where the pebbles were found to bear *Schwagerina lutugini*, the detritals must all be younger than "the highest limestones of the plateau." Kay has shown this section graphically (his Fig. 2A, page 1398) and indicated the position of the pebbles bearing *Schwagerina lutugini*. But he overlooked the significance of other fossils that occur in abundance at various horizons throughout the entire section (Fig. 3). For example, Tolstikhina cites a band of fine-grained calcareous sandstone cropping out west of Shalia and belonging in the upper part of the "Middle Artinskian sandstone, clay and conglomerate series." From this she lists a brachiopod fauna of 24 species.[18] Of these, 14 species were figured and described long ago by Tschernyschew[19] from the limestones of the Ufa Plateau and 4 of the remainder were identified from the same limestones by Tolstikhina[20] in 1935. In short, the following 18 out of 24 species cited from this zone in the Artinskian sandstone occur also in the limestones of the Ufa Plateau: *Productus* [*Waagenoconcha*] *irginae*, *P.* [*W.*] *humboldti*, *P.* [*W.*] *aagardi*, *P.* [*Linoproductus*] *cora*, *P.* [*L.*] *kninckianus*, *P.* [*Cancrinella*] *cancriniformis*, *Chonetes uralicus*, *Marginifera uralica*, *M. typica*, *Hustedia remota*, *Camerophoria biplicata*, *C. pentameroides*, *Martinia semiglobosa*, *Rhynchopora variabilis*, *Brachythyris quadriradiata*.

In a higher zone, near Shamary, both mollusks and brachiopods are present, including the following species which also occur in the limestones of the Ufa Plateau: *Pronorites postcarbonicus*, *Productus* [*Horridonia*] *timanicus*, *P.* [*Waagenoconcha*] *irginae*, *P.* [*Linoproductus*] *cora*, *P.* [*L.*] *koninckianus*, *Spiriferella saranae*, *Spirifer* [*Neospirifer*] *"cameratus,"* *S.* [*N.*] *fasciger*, *Martinia triquetra*.

Collating the two lists, we have 20 species of brachiopods and one ammonite which occur in the "Middle Artinskian" of the particular section cited by Kay, and also in the limestones of the Ufa Plateau. Some of these, like *Linoproductus cora* and *Spirifer "cameratus,"* may have little significance, but others, such as *Horridonia timanicus*, *Waagenoconcha humboldti*, *W. irginae*, and *Spiriferella saranae*, are distinctive and highly specialized forms.

This is by no means a complete analysis of the extensive faunas of these regions, and such comparison must await more critical study of much ma-

[16] *Op. cit.*, p. 38.

[17] G. Marshall Kay, *op. cit.*, p. 1397.

[18] M. M. Tolstikhina, *op. cit.*, p. 40.

[19] Th. Tschernyschew, *op. cit.*, pp. 448–50.

[20] M. M. Tolstikhina, "Carboniferous Deposits of the Central Part of the Ufa Plateau," *Trans. Central Geol. and Prospecting Inst.*, Fasc. 65 (1935), pp. 1–35.

terial. It is certainly significant, however, that the majority of the species cited by Tolstikhina as characteristic of the Artinskian detritals east of Kungur are also characteristic of the limestones in the Ufa Plateau. In the absence of strong evidence to the contrary, this appears to be good evidence of similar, if not identical, age. Even if they are contemporaneous, it is surprising that the faunas should have so much in common in spite of the contrast in lithologic facies. Under the circumstances, it appears quite indefensible to refer the limestones to the Carboniferous and the detritals to the Permian merely on the basis of a single species of fusulines.

The one further point cited by Kay relates to the section on Kossva River west of Kizel where "more than 350 meters of *S. lutugini*-bearing limestone is succeeded 'without apparent unconformity' by 430 meters of Artinskian shaly sandstone and overlying conglomerate." This is the locality visited by the Permian excursion where the lower part of the *Sarga* limestone is overlain by beds of Artinskian facies. Inasmuch as *S. lutugini* occurs approximately 1,500 feet below the top of the limestone sequence farther west and south, this locality offers no obstacle to the interpretation that the detrital facies is progressively replacing the calcareous facies as presented by Dunbar.

Inasmuch as Kay's premises are untenable, much of the rest of his paper, interpreting the paleogeography and indicating the Carboniferous-Permian boundary, is groundless. His stratigraphic section seems particularly misleading. It represents three troughs of deposition, the "Uralian orthogeosyncline," the "Artinskian geosyncline," and a third trough farther west in which the Kungurian salines were deposited. But actually, as shown on the inset map in Figure 1, that part of his section between Nijniserginsk and Kizel runs north-northwest along the strike and parallel with the axis of the Urals and with that of the Uralian geosyncline. Kizel was apparently as close to the axis of the Urals as was Nijniserginsk, and if an "Artinskian geosyncline" existed between these points it must of necessity have crossed the "Uralian geosyncline." The present regional structure clearly indicates that this was not so.

It should be noted also that the part of Kay's section between Perm and Kungur follows closely the strike of the regional structure. If the section were drawn to a uniform horizontal scale this part would be greatly foreshortened. Furthermore, this section represents the limestones of the Ufa Plateau as though they extended eastward with undiminished thickness into the basin where the Artinskian detritals are thickest. Of course this is not true. In the section east of Kungur, discussed at length in the foregoing paragraphs, the "Upper Carboniferous" limestones are so nearly absent that no outcrops were visited by the Permian excursion. In discussing the Ufa Amphitheatre, Nalivkin[21] stated, "The Upper Carboniferous is scarcely developed, occurring as isolated spots among the Artinskian." At Sim Works, somewhat farther south, the Artinskian facies is known to extend as low as the base of the Sakmarian.[22] The poor development of the limestones in the region east of Kungur may well be due to change of facies; certainly no one has given evidence that limestones were upturned and truncated before Artinskian time as represented by Kay.

[21] B. V. Nalivkin, "The Ufa Amphitheatre," *Guidebook, Permian Excursion, Southern Part, Seventeenth Intern. Geol. Congress* (1937), p. 21.

[22] Carl O. Dunbar, "The Type Permian: Its Classification and Correlation," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 2 (February, 1940), pp. 246–47.

Remarks by G. MARSHALL KAY.—After reading the typescript of the paragraphs above, I must confess that the interpretation they give of the section east of Kungur in the Artinskian belt appears most probable in the light of the information now at hand. 1. Relations farther south present "compelling evidence that there are clastics of 'Artinskian' facies in the Urals that are equivalent to the limestones of the plateau," and these clastics are the Artinskian as defined by Karpinsky (quotations from my article). 2. It is most reasonable to believe that similar relations prevail to the north in the absence of other than tenuous evidence to the contrary. 3. Paleontologic evidence in the north is accordant with this interpretation. 4. Considering the lower part of this "Artinskian" to be equivalent to the limestones of the plateau, the upper part should be similarly classified. But however tenuous the faunal evidence for dating the lower Artinskian conglomerate, the presence of tuffaceous rocks and quartz pebbles is suggestive that it was derived from uplifts far to the east. The Artinskian paleogeography is of course dependent on the interpretation given to the foregoing correlations.

But regarding the Carboniferous-Permian boundary, the fact that (1) Murchison defined the limestones of the plateau as pre-Permian, and that (2) the disconformity above the limestones is the principal one recognized on the platform are considered important. If we accept the interpretation that the Artinskian clastics gradationally overlap the limestones, uplift to the east began earlier, and culminated at or near the close of limestone deposition. Placement is dependent on the criteria that are considered most significant.

CORRECTION
GAS IN ROCKINGHAM COUNTY, VIRGINIA

In the article, "Discovery of Gas in Rockingham County, Virginia," by Paul H. Price, in the February *Bulletin*, page 275, lines 10 and 11, the open flow of the C. L. Souder well should have been printed as "60 M cubic feet of gas," as originally written in the author's manuscript, not "60 million cubic feet" as erroneously prepared for the printer. The business manager's apologies!

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REVIEWS AND NEW PUBLICATIONS

* Subjects indicated by asterisk are in the Association library, and available, for loan, to members and associates.

RECENT PUBLICATIONS

ALBERTA

*"Steveville Oil and Gas Field, Alberta," by J. S. Stewart. *Canada Geol. Survey Paper 41-10* (Ottawa, 1941). 16 pp. and areal geological map 16.5×21 inches (scale: 1 inch=4 miles), showing Cretaceous formations and locations of wells. Price, $0.10.

*"Preliminary Map—Beaver Mines, Alberta," by C. O. Hage. *Ibid., Paper 41-12.* Sheet 30×46 inches (scale: 2 inches=1 mile), showing areas of Proterozoic, Paleozoic, and Mesozoic, locations of wells showing oil and gas, and 3 structure sections. Topographic contours: 100 feet. Price, $0.10.

*"Folded Thrust Faults in the Foothills of Alberta," by B. F. Hake, Robin Willis, and C. C. Addison. *Bull. Geol. Soc. America*, Vol. 53, No. 2 (New York, February 1, 1942), pp. 291–334; 17 figs.

ARGENTINA-BOLIVIA

*"Correlation of the Miraflores Calcareous Beds of Bolivia with the Calcareous-Dolomitic Horizon of Northern Argentina," by O. Schlagintweit. *Inst. Mus. Univ. Nac. La Plata*, Tomo VI, Geol. No. 14 (La Plata, Argentina, 1941), pp. 337–54; 9 figs. In Spanish.

ARKANSAS

*"Arkansas Discovery Opens Vast Region for Exploration," by Gordon B. Nicholson. *Oil Weekly*, Vol. 104, No. 11 (Houston, February 16, 1942), pp. 21–31; 3 photographs, 3 tables, an electric log, and 2 maps.

BRAZIL

*"Código de Taxionomia Estratigráfica" (Classification and Nomenclature of Rock Units), by Glycon de Paiva. *Brasil Div. Geol. e Min. Notas Preliminaires e Estudos 21* (Rio de Janeiro, July, 1940). 28 pp. Translated and adapted from *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 17, No. 7 (July, 1933), and Vol. 23, No. 7 (July, 1939). Portuguese.

*"Restingas na Costa do Brasil" (Barrier Beaches of the Coast of Brazil), by Alberto Ribeiro Lamego. *Ibid., Bol. N. 96* (1940). 63 pp., 48 figs. Portuguese.

*"Alguns Lamelibrânquios Triássicos do Brasil e do Paraquai" (Some Triassic Lamellibranchs from Brazil and Paraguay), by F. R. Cowper Reed. *Ibid., Bol. N. 98* (1940). 31 pp., pl. of fossils, 2 maps. Portuguese. Summary in English.

*"Geologia de Goiaz a Cuibá" (Geology from Goiaz [State of Goiaz] to Cuiba [State of Mato Grosso]), by Alberto I. Erichsen and Axel Löfgren. *Ibid., Bol. N. 102* (1940). 40 pp., 4 pls. of fossils, 7 photographs, 3 maps, 1 table, 1 large folded geologic map in colors. Portuguese. Summary in English.

*"Notas bibliográficas sôbre os Terrenos Gonduânicos do Brasil" (Biblio-

graphic Notes on the Gondwana of Brazil), by José Menescal Campos. *Ibid., Bol. N. 108* (1940). 39 pp. Portuguese.

*"O Devoniano do Paraná e Geografia e suas Relações com a Geologia" (Devonian of Parana and Geography Related to Geology), by Paulino Franco de Carvalho. *Ibid., Bol. N. 109* (1941). 39 pp., 5 figs., 4 photographs. Portuguese.

CALIFORNIA

*"California Well Spacing, War, and Geology," by William W. Porter II. *Oil Weekly*, Vol. 104, No. 11 (Houston, February 16, 1942), pp. 32–33.

*"Geologic History and Correlation of the Jurassic of Southwestern Oregon and California," by N. L. Taliaferro. *Bull. Geol. Soc. America*, Vol. 53, No. 1 (New York, January 1, 1942), pp. 71–112; 3 figs.

GENERAL

*"Recent Developments and Successes in Geodynamic Prospecting," by Sylvain J. Pirson. *Oil Weekly*, Vol. 104, No. 6 (Houston, January 12, 1942), pp. 20–30; 3 figs.

*"U. S. Reserves Show Slight Increase in 1941," by Michel T. Halbouty. *World Petroleum*, Vol. 13, No. 1 (New York, January, 1942), pp. 36–37.

**Bibliography of Military Geology and Geography*, prepared under the direction of W. H. Bucher. *Geol. Soc. America* (New York, December, 1941). 18 pp. "This bibliography has been compiled by the Division of Geology and Geography of the National Research Council and is being issued jointly by it and The Geological Society of America. It is designed as a guide for the American geologists and geographers who wish to inform themselves concerning the ways in which their special training and experience may become useful in an armed conflict."—From the Foreword. Write A.A.P.G. Headquarters, Box 979, Tulsa, Oklahoma, for free copy.

"Geophysics in War," by C. A. Heiland. *Colorado School of Mines Quar.*, Vol. 37, No. 1 (Golden, January, 1942). Approx. 100 pp., 47 photographs, diagrams, and charts. For sale by Colorado School of Mines Department of Publications, Golden. Price, $1.00.

"Geology and Biology of North America Deep-Sea Cores between Newfoundland and Ireland, Part 4, Ostracoda," by W. L. Tressler. *U. S. Geol. Survey Prof. Paper 196-C* (1941), pp. i–xv, 95–106, Pls. 1–2, 18–19, Fig. 1. Supt. Documents, Govt. Printing Office, Washington D. C. Price, $0.15.

*"Radioactivity of Ocean Sediments. V. Concentrations of the Radio-Elements and Their Significance in Red Clay," by Wm. D. Urry and C. S. Piggot. *Amer. Jour. Sci.*, Vol. 240, No. 2 (New Haven, Connecticut, February, 1942), pp. 93–103; 1 fig., 4 tables.

*"Handbook of Physical Constants," edited by Francis Birch, J. F. Schairer, and H. Cecil Spicer. *Geol. Soc. America Spec. Paper 36* (New York, January 31, 1942). 325 pp. 21 sections written by 19 contributors.

Oil Well Drainage, by Stanley C. Herold. xv+407 pp., 7×10 inches Stanford University Press, Stanford University, California (1942). Price, $5.00. Add 3 per cent sales tax in California.

*"Strategic Location of Wells in Flank Sands on Piercement-Type Salt Domes," *Anon. Oil Weekly*, Vol. 104, No. 4 (Houston, February 9, 1942), pp. 17–20; 3 figs.

*"New Frontiers in Micropaleontology, with Especial Reference to Petroleum Exploration," by Carey Croneis. *Econ. Geol.*, Vol. 37, No. 1 (Urbana, Illinois, January–February, 1942), pp. 16–38.

*"Important Reserves May Exist in Sedimentary Structures formerly Overlooked," by Norman C. Smith. *World Petrol.*, Vol. 13, No. 2 (New York, February, 1942), pp. 30–36; 6 diagrams in color.

*"Well Spacing, War, and Geology," by William W. Porter II. *California Oil World*, Vol. 35, No. 3 (Los Angeles, First Issue, February, 1942), pp. 6–8.

*"Instrument for Determining the Direction of Dip in Cores Taken in Inclined Holes," by C. F. C. Moore. *Jour. Inst. Petroleum*, Vol. 27, No. 216 (Birmingham, December, 1941), pp. 419–25; 2 figs.

*"A Preliminary Study of the Chemical Constitution of Kerogen," by A. L. Down and G. W. Himus. *Ibid.*, pp. 426–45; 2 figs., 7 tables.

ILLINOIS

"Contributions to Pennsylvanian Paleobotany-*Mazocarpon oedipternum* sp. nov., and Sigillarian Relationships," by James M. Schopf. *Illinois Geol. Survey R. I. 75* (Urbana, January, 1942). 53 pp., 6 pls. Price, $0.25. One copy free to residents of Illinois and to public libraries, for $0.015 postage until May 1, 1942.

KANSAS

*"Outlines of Kansas Geology, II," by Charles Keyes. *Pan-Amer. Geol.*, Vol. 77, No. 1 (Tucson, Arizona, February, 1942), pp. 43–62; 2 figs.

*"Geology and Ground-Water Resources of Stanton County, Kansas," by Bruce F. Latta. *Kansas Geol. Survey Bull. 37* (Lawrence, 1941). 119 pp., 9 pls., 6 figs., 5 tables.

*"Ground-Water Resources of Mississippian and Older Rocks in Bourbon, Crawford, Cherokee, and Labette Counties, Southeastern Kansas," by G. E. Abernathy. *Ibid., Bull. 38*, pp. 222–36; 1 fig.

*"Reconnaissance of Ground-Water Resources in Atchison County, Kansas," by John C. Frye. *Ibid.*, pp. 237–60; 3 pls., 6 figs.

*"Classification of the Marmaton Group, Pennsylvanian, in Kansas," by John M. Jewett. *Ibid.*, pp. 285–344; 9 pls.

*"The Otis Gas and Oil Pool, Rush and Barton Counties, Kansas," by Eugene A. Stephenson and John I. Moore. *Ibid.*, pp. 345–88; 17 figs., 17 tables.

*"Pliocene and Pleistocene Stratigraphy and Paleontology of the Meade Basin, Southwestern Kansas," by John C. Frye and Claude W. Hibbard. *Ibid.*, pp. 389–424; 3 figs., 4 pls.

*"The Geology of Riley and Geary Counties, Kansas," by John M. Jewett. *Ibid., Bull. 39.* 164 pp., 17 pls., 2 figs., 6 tables.

LOUISIANA

*"Olla and South Olla Fields, Louisiana," compiled by *Oil and Gas Jour.*, Vol. 40, No. 36 (Tulsa, January 15, 1942), pp. 66–67; 1 development map.

MISSISSIPPI

*"Forrest County Mineral Resources," by Vellore Meek Foster and Thomas Edwin McCutcheon. *Mississippi Geol. Survey Bull. 44* (University, 1941). 87 pp., 7 figs., 1 pl.

NEW MEXICO

*"Permian Lime-Secreting Algae from the Guadalupe Mountains, New Mexico," by J. Harlan Johnson. *Bull. Geol. Soc. America*, Vol. 53, No. 2 (New York, February 1, 1942), pp. 195–226; 7 pls., 5 figs.

NORTH DAKOTA

*"Selected Deep Well Records," by Wilson M. Laird. *North Dakota Geol. Survey Bull. 12* (Grand Forks, 1941). 31 pp.

*"The Geology of the Heart Butte Quadrangle," by Ernest E. Tisdale. *Ibid., Bull. 13.* 32 pp., 6 tables, 2 figs., 1 pl. (areal geology).

OHIO

*"The Age and Fossils of the Olentangy Shale of Central Ohio," by Roger C. Baker. *Amer. Jour. Sci.*, Vol. 240, No. 2 (New Haven, Connecticut, February, 1942), pp. 137–43; 3 pls.

*"Lower and Middle Mississippian Stratigraphy of Ohio," by Frederick T. Holden. *Jour. Geol.*, Vol. 50, No. 1 (Chicago, January-February, 1942), pp. 34–67; 4 figs., 8 tables.

OREGON

*"Geologic History and Correlation of the Jurassic of Southwestern Oregon and California," by N. L. Taliaferro. *Bull. Geol. Soc. America*, Vol. 53, No. 1 (New York, January 1, 1942), pp. 71–112; 3 figs.

PATAGONIA

**Geological Map of Patagonia below the 41st Parallel and of Tierra de Fuego*, compiled by Egidio Feruglio. Dirección General de Yacimientos Petrolíferos Fiscales, Buenos Aires, Argentina (1399). Sheet, 28×39 inches. Scale, 1 to 2,000,000. Areal geology in colors. Locations of gas emanations, asphalt, asphaltic and petroliferous rocks, and lignite.

PENNSYLVANIA

*"Oil and Gas Geology of the Franklin Quadrangle," by R. E. Sherrill and L. S. Matteson. *Pennsylvania Topog. Geol. Survey M 24* (Harrisburg, 1942). Price, $0.55.

*"Subsurface Sections across Western Pennsylvania," by Charles R. Fettke. *Pennsylvania Top. and Geol. Survey Prog. Rept. 127* (Harrisburg, August, 1941). 51 pp., 3 figs.

TASMANIA

*"The Composition of the Ash of Tasmanian Spore Shale," by G. W. Himus and S. Rudrakanchana. *Jour. Inst. Petroleum*, Vol. 27, No. 216 (Birmingham, December, 1941), pp. 446–47.

TEXAS

**Geology of Dallas County, Texas.* 134 pp., 25 figs., 4 pls. Prepared and published by the Dallas Petroleum Geologists (December, 1941). Barney Fisher, secretary-treasurer, 406 Continental Building, Dallas, Texas. Price, $0.75, postpaid.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGIST
VOL. 26, NO. 3 (MARCH, 1942), PP. 414-417

THE ASSOCIATION ROUND TABLE

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

The executive committee has approved for publication the names of the following candidates for membership in the Association. This does not constitute an election but places the names before the membership at large. If any member has information bearing on the qualifications of these nominees, he should send it promptly to the Executive Committee, Box 979, Tulsa, Oklahoma. (Names of sponsors are placed beneath the name of each nominee.)

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Willis Oliver Bazhaw, Tulsa, Okla.
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Philip Stockton Morey, San Antonio, Tex.
Leo R. Newfarmer, W. W. Hammond, R. N. Kolm

William Gamewell Pierce, Washington, D. C.
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Lon Davis, Jr., Floyada, Tex.
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Andros Gulde, Saginaw, Mich.
Edward J. Baltrusaitis, Jed B. Maebius, Carl C. Addison

Raymond Charles Gutschick, Urbana, Ill.
F. W. DeWolf, A. H. Sutton, Harold K. Wanless

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G. E. Archie, O. Wilhelm, Richard T. Lyons

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[1] From March, 1929, to March, 1932, the corresponding office was *first vice-president.*
[2] From March, 1929, to March, 1932, the corresponding office was *second vice-president in charge of finances.*
[3] From March, 1929, to March, 1932, the corresponding office was *third vice-president in charge of editorial work.*
[4] Died, November 25, 1927.
[5] Died, January 3, 1940.
[6] Died, January 10, 1939.
[7] Died, November 5, 1932.
[8] Died, January 29, 1940.
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BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 3 (MARCH, 1942), PP. 418-501

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS MEMBERSHIP LIST[1]

MARCH 6, 1942

HONORARY MEMBERS

The executive committee may from time to time elect as honorary members persons who have contributed distinguished service to the cause of petroleum geology. Honorary members shall not be required to pay dues.—*Sec. 6, Article III, of the Constitution.*

LIFE MEMBERS

The executive committee may grant life membership to members who have paid their dues and are otherwise qualified.—*Sec. 2, Article III, of the Constitution.*

On the payment of two hundred dollars ($200.00) any member in good standing shall be declared a life member and thereafter shall not be required to pay annual dues. —*Sec. 2, Article I, of the By-Laws.*

MEMBERS

Any person engaged in the work of petroleum geology or in research pertaining to petroleum geology or technology is eligible to active membership, provided he is a graduate of an institution of collegiate standing, in which institution he has done his major work in geology, or in sciences fundamental to petroleum geology, and in addition has had the equivalent of three years' experience in petroleum geology or in the application of these other sciences to petroleum geology or to research in petroleum geology or technology; and provided further that in the case of an applicant for membership who has not had the required collegiate or university training, but whose standing in the profession is well recognized, he shall be admitted to membership when his application shall have been favorably and unanimously acted upon by the executive committee, and provided further that these requirements shall not be construed to exclude teachers and research workers in recognized institutions whose work is of such character as in the opinion of the executive committee shall qualify them for membership.

Active members alone shall be known as members.—*Sec. 1, Article III, of the Constitution.*

ASSOCIATES

Any person having completed as much as thirty hours of geology (an hour shall here be interpreted as meaning as much as sixteen recitation or lecture periods of one hour each, or the equivalent in laboratory) in a reputable institution of collegiate or university standing, or who has done field work equivalent to this, is eligible to associate membership, provided at the time of his application for membership he shall be engaged in geological studies in an institution of collegiate or university standing, or shall be engaged in petroleum geology; and any person who is a graduate of an institution of collegiate standing, in which he has done his major work in sciences fundamental to petroleum geology or petroleum technology, and who has had the equivalent of one year's experience in the application of his science to the study of petroleum geology, shall be eligible to associate membership, provided at the time of his application for membership he shall be engaged in investigations in the broader subject of petroleum geology and technology.

Associate members shall be known as associates.

Associates shall enjoy all the privileges of membership in the Association, save that they shall not hold office, sign applications for membership, or vote; neither shall they have the privilege of advertising their affiliation with the Association in professional cards or professional reports or otherwise.—*Sec. 3, Article III, of the Constitution.*

[1] This list is published for the use of the members and for the information of all who wish to refer to the professional and business affiliations of the members. It is not a mailing address list and it is not intended to be used for circularizing or soliciting purposes.

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**Campbell, Marius R.
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Decker, Charles E., University of Oklahoma, Norman, Okla.
**Dumble, E. T.
Goodrich, Harold B., 1628 S. Cincinnati, Tulsa, Okla.
Harris, Gilbert D., Dept. of Geology, Cornell University, Ithaca, N. Y.
**Hill, Robert T.
Lawson, Andrew C., University of California, Bacon Hall, Berkeley, Calif.
Mendenhall, Walter C., U. S. Geological Survey, Washington, D. C.
Orcutt, W. W., Rancho Sombra del Roble, Canoga Park, Calif.
Ordoñez, Ezequiel, Abraham Gonzalez, 79, Mexico City, Mexico
**Reed, Ralph D.
**Salisbury, R. D.
Schuchert, Charles, Yale University, New Haven, Conn.
Smith, George Otis, Box 308, Skowhegan, Me.
Stille, Hans, Geological Institute, University of Berlin, Berlin, Germany
Taff, Joseph A., 628 Cowper St., Palo Alto, Calif.
**Udden, Johan August
Ulrich, E. O., National Museum, Washington, D. C.
van der Gracht, W. A. J. M., 36 Eeuwige Laan, Huize Jachtduin, Bergen (N. H.), Netherlands
**von Hofer, Hans Hofrat
**White, David
**White, I. C.
Woolnough, W. G., "Callabonna," 8 Park Ave., Gordon, N.S.W., Australia

** Deceased.

COMPLETE LIST OF MEMBERS, ASSOCIATES, HONORARY MEMBERS, AND LIFE MEMBERS

Honorary	15
Life	6
Members	2,922
Associates	777
Total	3,720

EXPLANATION OF SYMBOLS

* Honorary member. † Life member. ‖ Associate. Members are not marked. The year refers to the date of election to membership.

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Abell, George T., independent, Box 430, Midland, Tex. '29
Abernathy, G. E., Kansas Geol. Survey, Pittsburg, Kan. '38
‖Absher, K. B., Box 240, Mattoon, Ill. '25
Absher, William F., Cities Service Oil Co., Geol. Dept., Bartlesville, Okla. '20
‖Acheson, Cyrus Harold, Tropical Oil Co., El Centro, Colombia, S. A. '39
Achning, Walter J., 1101 Milam Bldg., San Antonio, Tex. '38
Ackerman, E. Dumont, Standard Oil Co. of Venezuela, Caripito, Venezuela, S. A. '40
Ackers, A. L., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla. '25
Ackley, Kenneth A., Carter Oil Co., Box 568, Mattoon, Ill. '38
Adams, Bradford C., The Texas Co., 1102 Fifth St., Los Banos, Calif. '41
Adams, Clyde B., Socony-Vacuum Oil Co., Inc., 26 Broadway, New York, N. Y. '41
Adams, Elmo W., Honolulu Oil Corp., 215 Market St., San Francisco, Calif. '30
Adams, Frank C., consulting, 902 Electric Bldg., Houston, Tex. '27
Adams, John Emery, Standard Oil Co. of Texas, Carlsbad, N. M. '29
Adams, Kilburn E., The Texas Co., Box 2420, Tulsa, Okla. '38
Adams, W. C., Box 1666, Houston, Tex. '24
Addison, Carl C., Pure Oil Co., 402 Second Natl. Bank Bldg., Saginaw, Mich. '30
Adkins, W. S., Shell Oil Co., Inc., Houston, Tex. '20
‖Adkisson, Albert, producer, 2019 W. T. Waggoner Bldg., Fort Worth, Tex. '34

Adler, Joseph L., 901 Esperson Bldg., Houston, Tex.....'30
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Agey, Charles S., Amerada Petr. Corp., Box 995, Wichita, Kan.....'38
Agnich, Fred J., Geophysical Service, Inc., 1311 Republic Bank Bldg., Dallas, Tex..'41
Aguerrevere, Pedro I., Apt. 1253, Caracas, Venezuela, S. A.....'24
Aguerrevere, Santiago E., Sur 3, No. 94, Caracas, Venezuela, S. A.....'24
Aimer, James D., Arkansas Nat. Gas Corp., Drawer 1734, Shreveport, La.....'26
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Allan, John Andrew, University of Alberta, Edmonton, Alta., Canada.....'30
Allan, Thomas H., 921 Union Natl. Bank Bldg., Wichita, Kan.....'24
‖Allardyce, Robert L., Jr., 2820 Pine St., Texarkana, Ark.....'42
Allen, Alton C., Rowan & Nichols Oil Co., 903 Trinity Life Bldg., Fort Worth, Tex.....'35
‖Allen, Charles F., 1002 K St., Bakersfield, Calif.....'42
Allen, Devere F., 3000 Sowers Court, Topeka, Kan.....'29
Allen, Donald M., Signal Oil Co., 612 Orpheum Bldg., Wichita, Kan.....'24
Allen, E. G., 4601 Park Lane, Dallas, Tex.....'17
‖Allen, Frank T., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa.....'39
Allen, Harris Hayes, Phillips Petr. Co., Bartlesville, Okla.....'39
‖Allen, John O., Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A.....'41
Allen, Stanley R., 230 E. Doddridge St., Kingsville, Tex.....'35
‖Allen, William Hammond, Shell Oil Co., Inc., Box 1509, Midland, Tex.....'40
‖Allen, William Odis, Jr., independent, 1331 E. Twenty-sixth St., Tulsa, Okla.....'39
Allison, A. P., Sun Oil Co., Box 2645, Houston, Tex.....'21
Allon, Michael, Box 628, Chickasha, Okla.....'37
‖Alquist, Francis Nelson, Dow Chemical Co., Midland, Mich.....'38
‖Alvarado, Benjamin, Carrera 13 No. 15–30, Bogota, Colombia, S. A.....'38
Alvarez, Manuell, Jr., Ignacio Mariscal 12-A, Mexico, D. F., Mex.....'36
Ambrose, A. W., Cities Service Oil Co., Bartlesville, Okla.....'19
Ames, Edward W., consulting, Box 921, Denver, Colo.....'19
‖Andersen, Harold V., Route 1, Box 29-C, Birmingham, Ala.....'40
Anderson, Amil A., 3011 Stockbridge Ave., Los Angeles, Calif.....'22
Anderson, Carl B., Gulf Refg. Co., Box 482, Mattoon, Ill.....'19
Anderson, Carl C., U. S. Bureau of Mines, Box 2250, Amarillo, Tex.....'32
‖Anderson, Carl T., Republic Nat. Gas Co., 1505 Federal St., Dallas, Tex.....'41
Anderson, Frank M., 58 Hill Crest Rd., Berkeley, Calif.....'24
‖Anderson, Frank Marion, University Lands, Box 1663, Midland, Tex.....'42
Anderson, George H., Texas Power & Light Co., 823 Interurban Bldg., Dallas, Tex..'40
‖Anderson, J. Q., Union Oil Co. of Calif., Coalinga, Calif.....'40
Anderson, James B., 415 W. Lomita Ave., Glendale, Calif.....'38
Anderson, John G., 815 Chronicle Bldg., Houston, Tex.....'21
‖Anderson, Oscar S., Jr., Big Four Petr. Co., Box A, Oilton, Okla.....'39
Anderson, Ray Ball, Columbian Carbon Co., Box 1240, Charleston, W. Va.....'24
‖Anderson, Robert G., Box 924, Coleman, Tex.....'38
Anderson, Tom A., Geophysical Dept., Standard Oil Co. of La., Box 1739, Shreveport, La.....'36
‖Anderson, Thomas I., 2250 Parnell Ave., W. Los Angeles, Calif.....'40
Anderson, W. D., Amerada Petr. Corp., Box 1366, Midland, Tex.....'27
Andrau, E. W. K., consulting, Box 2408, Houston, Tex.....'32
Andrews, Philip, Socony-Vacuum Oil Co., Apt. 246, Caracas, Venezuela, S. A.....'25
Andrews, Thomas G., Univ. of Alabama, University, Ala.....'37

Andrews, W. W., Humble Oil & Refg. Co., Box 2180, Houston, Tex.....'36
‖Anisgard, Harry W., 503 W. One Hundred Twenty-fourth St., New York, N. Y.....'41
Apfel, Earl T., 210 Buffington Rd., Syracuse, N. Y.....'29
Applin, Paul L., consulting, 2317 W. Magnolia, Fort Worth, Tex.....'19
Archie, Gustave E., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'38
‖Arellano, A. R. V., Apt. 7527, Mexico, D. F., Mex.....'38
Argabrite, William Graeme, consulting, Box 33, Lewisburg, W. Va.....'28
Arick, M. B., Midland, Tex.....'27
Arleth, Karl, 2215 El Molino Pl., San Marino, Calif.....'39
Armstrong, Earle N., Shamrock Oil & Gas Corp., Amarillo, Tex.....'33
Armstrong, Harold K., consulting, 1002 Edison Bldg., Los Angeles, Calif.....'27
Armstrong, J. M., consulting, Box 990, Midland, Tex.....'18
Arnold, Emmett L., Box 911, Balboa, Canal Zone.....'27
Arnold, H. H., The Texas Co., Box 2420, Tulsa, Okla.....'27
Arnold, Henry C., British-American Oil Prod. Co., 505 Philtower Bldg., Tulsa, Okla...'30
‖Arnold, Lincoln Merchant, Geologic Standards Co., 321 S. Detroit, Tulsa, Okla...'39
Aronson, Sam M., independent, 1408 Magnolia Bldg., Dallas, Tex.....'24
‖Arper, William B., Jr., 756 Jenkins, Norman, Okla.....'41
‖Artusy, Ray, United Gas System, Rusk Bldg., Houston, Tex.....'38
Ashauer, Hans F., The Texas Co., 117 Jefferson St., Coalinga, Calif.....'37
Ashley, Burton E., The Texas Co., Box 1801, Wichita, Kan.....'37
Ashley, Richard M., 815 Illinois, Neodesha, Kan.....'39
Athy, Lawrence F., Geophysical Div., Continental Oil Co., Ponca City, Okla.....'26
Atwater, Gordon I., c/o William Helis, 912 Whitney Bldg., New Orleans, La.....'38
Atwill, E. R., Union Oil Co. of Calif., 617 W. Seventh St., Los Angeles, Calif.....'31
Augenthaler, Robert L., Box 930, Merced, Calif.....'38
Aurand, Harry A., consulting, 1350 Bellaire St., Denver, Colo.....'26
Aurin, Fritz L., Southland Royalty Co., 1607 Trinity Life Bldg., Fort Worth, Tex..'17
‖Austin, Robert B., A. P. O. 40, Co. B, 115th Engineers, San Luis Obispo, Calif...'41
Autry, Vernon E., Fain-McGaha Oil Corp., 607 Hamilton Bldg., Wichita Falls, Tex.....'26
Avery, C. Dwight, U. S. Geol. Survey, 3240 Interior Bldg. N., Washington, D. C...'28
‖Aycock, Lester C., White Castle, La.....'41
Ayers, Floyd M., N.K.P.M., Soengei Gerong, Palembang, Sumatra, N. E. I.....'30

‖Babin, Logan H., 127 Columbus St., Houma, La.....'38
Bace, A. C., Stanolind Oil & Gas Co., Philcade Bldg., Tulsa, Okla.....'24
‖Bachman, Ford F., 25th Bn., 7th Reg., Branch Immaterial Replacement Tng. Center, Fort McClellan, Ala.....'41
‖Back, Denys H., Yuan Development Co., 1422 Esperson Bldg., Houston, Tex...'37
‖Backman, John E., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa.....'39
Bacon, Charles S., Jr., Geol. Dept., Texas A. & M. College, College Station, Tex...'29
Baddley, E. R., The Texas Co., 929 S. Broadway, Los Angeles, Calif.....'36
Bader, G. E., Humble Oil & Refg. Co., 802 Humble Bldg., Houston, Tex.....'34
Badoux, Heli, Iraq Petr. Co., Ltd., Box 15, Deir-ez-Zor, Syria.....'38
‖Baer, Daurice Frank, c/o Jasper A. Baer, Monticello, Ind.....'42
Bailey, James P., 824 N. Orlando Ave., Hollywood, Calif.....'31
‖Bailey, Joe E. L., 1201 E. Eleventh St., Winfield, Kan.....'30
Bailey, John J., Argo Oil Co., 211½ N. Colorado, Midland, Tex.....'37
Bailey, Thomas L., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'24
Bailey, Willard F., Skelly Oil Co., 505 First Natl. Bank Bldg., Midland, Tex.....'35
Bain, H. Foster, 17 Battery Pl., New York, N. Y.....'26
Baird, C. A., Mene Grande Oil Co., Apt. 709, Caracas, Venezuela, S. A.....'21
Baker, Arthur A., U. S. Geol. Survey, Washington, D. C.....'30
Baker, Norval E., Near East Development Corp., Rm. 2611, 26 Broadway, New York, N. Y.....'27
Baker, Raymond F., Geol. Dept., The Texas Co., 135 E. Forty-second St., New York, N. Y.....'17
Baker, William A., Jr., consulting, 1515 Esperson Bldg., Houston, Tex.....'24
Bakke, W. E., First Natl. Bank, St. Louis, Mo.....'28
Baldwin, Ben F., Stanolind Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan. .....'39

Baldwin, E. B., consulting, Esperson Bldg., Houston, Tex. . . . '29
Bale, Hubert E., consulting, 433 Liberty Natl. Bank Bldg., Oklahoma City, Okla. . '24
Ball, John R., Dept. of Geology, Northwestern Univ., Evanston, Ill. . . . '40
Ball, Max W., Abasand Oils, Ltd., Credit Foncier Bldg., Edmonton, Alta., Canada . . . '19
‖Ballantyne, R. S., Jr., 1230 S. Citrus Ave., Los Angeles, Calif. . . . '40
‖Ballard, Gene, Seaboard Oil Co., Box 396, Kerman, Calif. . . . '40
Ballard, James L., Tide Water Assoc. Oil Co., 602 Driscoll Bldg., Corpus Christi, Tex. . . . '25
Ballard, William Norval, 1105 N. E. Twentieth St., Oklahoma City, Okla. . . . '29
Baltrusaitis, Edward Joseph, Gulf Refg. Co., Box 811, Saginaw, Mich. . . . '40
Banks, Thomas R., 921 Cambridge Oval, San Antonio, Tex. . . . '27
Banta, H. E., 1922 W. Gray, Houston, Tex. . . . '40
Barbat, William F., Prod. Dept., Standard Oil Co., Taft, Calif. . . . '28
Barber, Clifford F., 1217 Commerce Bldg., Houston, Tex. . . . '37
‖Barbour, Richard Morton, consulting, 129 E. Riverside Dr., Evansville, Ind. . . . '40
‖Barclay, Stewart, Geophysical Div., Phillips Petr. Co., Bartlesville, Okla. . . . '39
Bard, Richards J., N. K. P. M. Pendopo, Soengei Gerong, Palembang, Sumatra, N. E. I. . . . '28
‖Barger, Thomas C., California Arabian Standard Oil Co., Bahrein Island, Persian Gulf . . . '40
‖Barling, Robert, Miller Geophysical Co., 1025 Twenty-sixth St., Bakersfield, Calif. . '27
Barlow, Victor, Burneol Petr. Co., 812 Subway Terminal Bldg., Los Angeles, Calif. . '27
Barnes, Chester F., Box 1470, Big Spring, Tex. . . . '35
Barnes, Roy M., Continental Oil Co., 601 W. Fifth St., Los Angeles, Calif. . . . '24
‖Barnes, Sydney U., 1267 N. Normandie Ave., Hollywood, Calif. . . . '41
Barnett, D. G., Geol. Dept., Union Prod. Co., Beeville, Tex. . . . '25
Barnett, J. A., U. S. Geol. Survey, Roswell, N. Mex. . . . '28
Barnett, John F., Palacios, Tex. . . . '39
Barney, A. Y., Columbian Carbon Co., Box 1240, Charleston, W. Va. . . . '30
Barnhart, Carl F., Amerada Petr. Corp., Box 591, Midland, Tex. . . . '29
Barnwell, George F., New Zealand Petr. Co., Box 295, Gisborne, N. Z. . . . '28
Barr, Kenneth William, Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B. W. I. . . . '39
Barragy, Edward J., Texas Gulf Prod. Co., 1311 Esperson Bldg., Houston, Tex. . . '31
Barret, William M., Giddens-Lane Bldg., Shreveport, La. . . . '32
Barrett, Albert F., General Petr. Corp., Casper, Wyo. . . . '30
‖Barrett, Henry H., Carter Oil Co., Box 1151, Seminole, Okla. . . . '41
Barrett, John F., International Petr. Co., Guayaquil, Ecuador, S. A. . . . '40
Barrow, Geoffrey, Tropical Oil Co., El Centro, Colombia, S. A. . . . '31
Barrow, Leonidas T., Humble Oil & Refg. Co., Houston, Tex. . . . '22
‖Barry, John O'Keefe, 701 Meriam St., Plaquemine, La. . . . '41
Bartell, Laurence D., Skelly Oil Co., 419 Ardis Bldg., Shreveport, La. . . . '27
Bartle, Glenn G., Univ. of Kansas City, Kansas City, Mo. . . . '27
Bartlett, C. Lothrop, Sun Oil Co., Box 2831, Beaumont, Tex. . . . '28
Bartlett, Fred W., Socony-Vacuum Oil Co., 26 Broadway, New York, N. Y. . . . '24
‖Bartley, Jerald Howard, University Lands, Box 1663, Midland, Tex. . . . '39
‖Barton, Jack M., Magnolia Petr. Co., Box 1828, Oklahoma City, Okla. . . . '38
Barton, Louis A., Arkansas Louisiana Gas Co., Rm. 1128, Slattery Bldg., Shreveport, La. . . . '20
Bartosh, E. J., Bankline Oil Co., 437 S. Hill St., Los Angeles, Calif. . . . '28
Bartram, John G., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla. . . . '17
Bartram, Paul L., Phillips Petr. Co., Box 958, Ardmore, Okla. . . . '27
Barwick, John S., Ranger Oil Co., 715 Union Natl. Bank Bldg., Wichita, Kan. . . . '24
Bass, N. W., U. S. Geol. Survey, Tulsa, Okla. . . . '25
Bass, Perry R., 2106 Fort Worth Natl. Bank Bldg., Fort Worth, Tex. . . . '36
Bateman, A. F., Jr., 467 Custom House, Denver, Colo. . . . '36
Bateman, Alan M., Yale University, Drawer 91-A, New Haven, Conn. . . . '20
‖Bates, Charles C., 2nd F. A. Observation Bn., Camp Bowie, Tex. . . . '40
Bates, Fred W., Box 175, 110 Seville Blvd., Lafayette, La. . . . '36
Bates, R. P., producer, Springer Bldg., Tulsa, Okla. . . . '30
‖Bates, Robert L., New Mexico School of Mines, Socorro, N. Mex. . . . '40

Batla, Thomas Woodrow, Houston Oil Co. of Texas, Box 2412, Houston, Tex.....'41
Bauermann, Max K. H., De Bataafsche Petr. Mij., Carel van Bylandtlaan 30, The Hague, Netherlands.....'27
Bauernschmidt, A. J., Jr., Magnolia Petr. Co., Box 426, Vanderbilt, Tex.....'27
Baughman, George W., 529 N. Fountain, Wichita, Kan.....'36
Bay, Harry X., The Texas Co., Box 2332, Houston, Tex.....'30
Bayer, H. M., Gulf Oil Corp., Midland, Tex.....'25
Baysinger, Eugene M., Box 210, Lake Charles, La.....'36
Beach, Hugh H., Geological Survey, Victoria Museum, Ottawa, Ont., Canada....'41
Beach, John H., Shell Oil Co., Inc., Box 999, Bakersfield, Calif.....'37
Beal, Carl H., consulting, 5658 Wilshire Blvd., Los Angeles, Calif.....'19
‖Beal, Carlton, 163 Granville Ave., W. Los Angeles, Calif.....'39
Bean, Ward C., 2407 Berkeley Dr., Wichita Falls, Tex.....'18
Bear, Melvern F., Sharon Drilling Co., 204 Derby Bldg., Wichita, Kan.....'36
Beardsley, William R., Interstate Gas Co., Box 1087, Colorado Springs, Colo.....'40
Beatty, Robert M., 1710 Esperson Bldg., Houston, Tex.....'27
Beck, A. F., Geophysical Dept., Cities Service Oil Co., Bartlesville, Okla.....'27
Beck, Elfred, 717 McBirney Bldg., Tulsa, Okla.....'20
‖Beck, R. Stanley, Richfield Oil Corp., Box 1710, Bakersfield, Calif.....'38
Beck, Robert W., Carter Oil Co., Box 568, Mattoon, Ill.....'36
Beckelhymer, Roy L., Union Prod. Co., Box 2492, Houston, Tex.....'26
‖Becker, Dwight L., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'38
Becker, Herman Carroll, Seismograph Service Corp., 709 Kennedy Bldg., Tulsa, Okla.....'38
Becker, Raymond C., Union Prod. Co., Box 1407, Shreveport, La.....'38
Beckmann, Harry L., Humble Oil & Refg. Co., Midland, Tex.....'42
Beckmann, Lawrence J., Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A...'38
Beckwith, R. H., Geol. Dept., Univ. of Wyoming, Laramie, Wyo.....'38
Bednar, William Carr, 930 Lahoma Ave., Norman, Okla.....'40
Beebe, B. W., 236 S. Belmont, Wichita, Kan.....'37
‖Beeker, Ralph E., Pure Oil Co., Route 2, Saginaw, Mich.....'41
Beekly, Albert L., Mid-Continent Petr. Corp., Box 381, Tulsa, Okla.....'19
Beers, Roland, Research Laboratory, Geotechnical Corp., Box M, Lincoln, Mass...'31
Behre, Charles H., Jr., Dept. of Geology, Columbia Univ., New York, N. Y.....'29
Beilharz, Carl F., Pure Oil Co., Box 239, Houston, Tex.....'27
Belknap, Ralph L., Univ. of Michigan, Ann Arbor, Mich.....'31
Bell, Alfred H., Illinois Geol. Survey, Urbana, Ill.....'28
Bell, A. Lyndon, International Petr. Co., Ltd., Negritos, Peru, S. A.....'36
Bell, Douglas E., Humble Oil & Refg. Co., Houston, Tex.....'36
Bell, Frank W., Shell Oil Co., Inc., Hill & Obispo Sts., Long Beach, Calif.....'29
Bell, Harry Wesley, c/o Minerals Division, Ninth Floor, Capitol Bldg., Baton Rouge, La.....'22
Bell, Olin G., Humble Oil & Refg. Co., Houston, Tex.....'20
Belt, Ben C., Gulf Oil Corp., Drawer 2100, Houston, Tex.....'19
‖Bemis, Harold C., 205 E. Short St., Whittier, Calif.....'39
Benedum, Darwin, 1142 Milam Bldg., San Antonio, Tex.....'27
‖Benish, Robert L., Atlantic Refg. Co., Box 1346, Houston, Tex.....'39
‖Benke, Roy, Atlantic Refg. Co., Shreveport, La.....'39
‖Bennett, Ethel Evans, Texas Christian Univ., Fort Worth, Tex.....'38
Bennett, Frank O., Coralena Oil Co., 929 Kennedy Bldg., Tulsa, Okla.....'41
Bennett, Johnson, B. O. D. Co., Ltd., Qaiyarah, Iraq.....'37
‖Bennett, Malcolm D., Jr., Continental Oil Co., Houston, Tex.....'39
Bennett, Robert R., Div. of Ground Water, U. S. Geol. Survey, Washington, D. C...'39
‖Bennett, Robert Turner, Mt. Vernon, Iowa.....'41
Benson, Dale L., Sinclair Prairie Oil Co., Box 480, Corpus Christi, Texas.....'25
Benson, Don G., Sinclair Prairie Oil Co., Box 2411, Houston, Tex.....'31
Benton, L. B., 3332 Ryan Ave., Fort Worth, Tex.....'20
Bentz, A., Institution of Petr. Geology, Invalidenstr. 44, Berlin, N. 4, Germany..'34
Berg, Gilman A., Standard Oil Co. of Texas, Box 1249, Houston, Tex.....'38
Berg, Karl A. E., Northern Pacific Ry., 508 Securities Bldg., Billings, Mont.....'41
Berger, Walter R., c/o Cummins & Berger, 1603 Trinity Life Bldg., Fort Worth, Tex.....'17

‖Bernard, Hugh Allen, Southwestern Institute, Box 474, Lafayette, La.....'40
Bernard, W. E., Gulf Oil Corp., Box 661, Tulsa, Okla.....'21
Bernoulli, W., Geol. Dept., Museum of Nat. History, Basle, Switzerland.....'24
Bernt, Daniel M., Jr., 621 N. Sycamore Dr., San Gabriel, Calif.....'37
Berry, George F., Jr., Cities Service Oil Co., Eldorado, Kan.....'36
Berwald, W. B., The Ohio Oil Co., Box 981, Tulsa, Okla.....'23
Berwick, James D., Imperial Oil Co., Geol. Dept., 56 Church St., Toronto, Ont., Canada.....'36
‖Bescher, Earl, Jr., A.C.T.D., Corsicana, Tex.....'41
Best, J. Boyd, Mills Bennett Prod. Co., 3402 Gulf Bldg., Houston, Tex.....'21
‖Beuck, W. F., International Petr. Co., Box 803, Guayaquil, Ecuador, S. A.....'42
Bevier, George M., 911 Milam Bldg., San Antonio, Tex.....'21
Bierman, Alfred C., consulting, 821 S. Robertson Ave., Tyler, Tex.....'19
Billings, M. H., c/o Nonmetal Economics Div., U. S. Bur. Mines, Dept. of the Interior, Washington, D. C.....'38
Billingsley, J. E., Commonwealth Gas Corp., Box 404, Charleston, W. Va.....'30
Bingham, D. H., Phillips Petr. Co., Levy Bldg., Lafayette, La.....'21
Bingman, Neal J., Amerada Petr. Corp., Box 591, Midland, Tex.....'30
‖Birembaut, Arthur, Section Geologique du H. C., Beyrouth (Liban).....'41
Birk, Ralph A., Bridwell Oil Co., 814 City Natl. Bank Bldg., Wichita Falls, Tex...'20
Birkhauser, Max, Shell Oil Co., Inc., Box 691, Ventura, Calif.....'26
‖Bisbee, Wallace A., 242 W. Tenth St., Bristow, Okla.....'40
Bishop, Bradford, 920 Oliver St., S. Pasadena. Calif.....'36
Bishop, F. L., Geophysical Service, Inc., 1813 Natl. Bank of Tulsa Bldg., Tulsa, Okla.....'40
Bishop, Margaret Stearns, 203 S. East St., Cassopolis, Mich.....'38
‖Bivens, W. E., Jr., Railroad Commission of Texas, Oil & Gas Div., Corpus Christi, Tex.....'41
Black, Jo Pat, 1810 Petroleum Bldg., Houston, Tex.....'32
Blackburn, Willis C., Humble Oil & Refg. Co., Tampa, Fla.....'28
Blackstone, D. L., 208 Swallow Hall, Columbia, Mo.....'37
Blackwelder, Eliot, Box N, Stanford University, Calif.....'19
‖Blackwell, William G., Dept. of Minerals, 111 Civil Court Bldg., New Orleans, La..'39
‖Blair, Robert W., Gravity Service Co., 551 Marion St., Denver, Colo.....'39
Blanchard, Frank N., Skelly Oil Co., Box 1822, Pampa, Tex.. .....'37
Blanchard, J. B., independent, Box 1575, Alice, Tex.....'31
Blanchard, Stanley W., independent, Box 1575, Alice, Tex.....'39
Blank, Horace R., Soil Conservation Service, Box 26, Waco, Tex.....'38
Blanpied, B. W., Gulf Refg. Co., Drawer 1731, Shreveport, La.....'23
Blau, Ludwig W., Humble Oil & Refg. Co., Houston, Tex.....'30
‖Bleakley, Alfred B., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla.....'39
Bleecker, Edward S., 1615 Whitehall Bldg., 17 Battery Pl., New York, N. Y.....'21
‖Bleyberg, Arnold, Fohs Oil Co., 1340 Esperson Bldg., Houston, Tex.....'40
Blixt, John E., The Texas Co., Box 2100, Denver, Colo.....'40
Blodget, Ward B., independent operator, 714 W. Olympic Blvd., Los Angeles, Calif.....'24
Bloesch, Edward, consulting, 1410 Philtower Bldg., Tulsa, Okla.....'17
Blouin, Cecil F., Navarro Oil Co., Alice, Tex.....'39
Bocock, Oscar L., The Texas Co., Box 2332, Houston, Tex.....'38
Bode, Francis D., California Inst. of Technology, Pasadena, Calif.....'38
‖Bodkin, Hillard W., Superior Oil Co., 1004 Citizens Natl. Bank Bldg., Evansville, Ind.....'39
Boehms, Eugene F., Forest Development Corp., 1229 Milam Bldg., San Antonio, Tex.....'31
‖Boggs, Frank S., Jr., 1017 N. Eldorado St., Stockton, Calif.....'40
Bohart, Philip H., Gulf Oil Corp., Box 661, Tulsa, Okla.....'23
Boling, Kenneth G., Geol. Dept., Pure Oil Co., Box 311, Olney, Ill.....'38
‖Bolinger, John W., Humble Oil & Refg. Co., 202 Humble Bldg., Houston, Tex...'38
Bolyard, Garrett L., Box 189, Houma, La.....'27
Bonar, R. E., Forest Development Corp., 1229 Milam Bldg., San Antonio, Tex...'40
Bong, Carl P., 3237 Topeka, Corpus Christi, Tex.....'27
Boone, Dan E., Halliburton Oil Well Cementing Co., Box 2535, Houston, Tex.....'35

Boos, C. Maynard, consulting, 2036 S. Columbine St., Denver, Colo. . . . . '26
Boos, Edward J., Box 118, Spring Lake, Mich. . . . . '27
Booth, Robert T., Standard Oil Co. of Texas, Petroleum Bldg., Houston, Tex. . . . . '34
Booth, William Norfolk, 2011 Beale Ave., Bakersfield, Calif. . . . . '38
Boots, Paul H., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa. . . . . '35
‖Borax, Eugene, 3843 City Terrace Dr., Los Angeles, Calif. . . . . '41
Borden, Joseph L., Pure Oil Co., Box 271, Tulsa, Okla. . . . . '27
Borden, S. P., 1116 City Bank Bldg., Shreveport, La. . . . . '24
Boreing, M. J., c/o Bird & Boreing, 711 Union Natl. Bank Bldg., Wichita, Kan. . '40
‖Borger, Harvey D., Standard Oil Co., Caripito, Venezuela, S. A. . . . . '38
‖Boring, M. O., Jr., M-B-K Drilling Co., Odessa, Tex. . . . . '38
‖Born, Howard R., 2105 Gulf Bldg., Houston, Tex. . . . . '39
Born, Kendall E., State Division of Geology, Nashville, Tenn. . . . . '37
Born, W. T., Geophysical Research Corp., 2607 N. Boston Pl., Tulsa, Okla. . . . . '32
Bornhauser, Max, Continental Oil Co., Box 569, Lafayette, La. . . . . '28
Bossard, Leon, New Zealand Petr. Co., Box 295, Gisborne, N. Z. . . . . '29
Bostick, Francis X., independent, 1947 Danville, Houston, Tex. . . . . '42
Bostick, J. Wallace, 4648 Waneta Dr., Dallas, Tex. . . . . '19
Boutakoff, Nicholas, Kern Trinidad Oilfields, Box 55, San Fernando, Trinidad, B. W. I. . . . . '41
Bowen, Charles F., 1231 E, 4 South, Salt Lake City, Utah . . . . . '20
Bowen, Gilbert T., 1705 Monte Vista Dr., Whittier, Calif. . . . . '38
Bowen, James P., Panhandle Refg. Co., Wichita Falls, Tex. . . . . '18
Bower, John O., Texas Petr. Co., Apartado Postal 877, Bogota, Colombia, S. A. . . '29
Bowes, Glenn H., Continental Oil Co., 601 W. Fifth St., Los Angeles, Calif. . . . . '24
Bowler, James W., Colombian Petr. Co., Apt. 100, Cucuta, Colombia, S. A. . . . . '39
Bowles, Edgar O., 5000 Massachusetts Ave., Washington, D. C. . . . . '40
Bowles, R. C., Standard Oil Co. of Kansas, Box 256, Houston, Tex. . . . . '27
Bowles, Thomas K., The Ohio Oil Co., Box 193, Bakersfield, Calif. . . . . '37
Bowling, Leslie, Union Oil Co. of Calif., 1134 Commerce Bldg., Houston, Tex. . . '30
Bowman, Wayne F., consulting, 2342 Rice Blvd., Houston, Tex. . . . . '19
Bowser, William F., Lion Oil Refg. Co., Wichita, Kan. . . . . '27
‖Bowsher, Arthur Leroy, Kansas State Geol. Survey, Lawrence, Kan. . . . . '42
Boyd, Harold E., consulting, 536 Lincoln Ave., Palo Alto, Calif. . . . . '17
Boyd, Lewis H., 1712 First St., Bakersfield, Calif. . . . . '41
Boyd, W. Baxter, Continental Oil Co., Ponca City, Okla. . . . . '29
Boyer, Will W., consulting, 1741 Milam Bldg., San Antonio, Tex. . . . . '28
Boylan, Ebert E., Caracas Petr. S. A., Apt. 89, Caracas, Venezuela, S. A. . . . . '19
Boyle, Walter J., Foster Petr. Corp., 1731 Milam Bldg., San Antonio, Tex. . . . . '26
Boyles, James M., 3512 Travis St., Houston, Tex. . . . . '31
Bracaccini, Osvaldo I., Dto. Exploraciones, Y.P.F., Avda. R. S. Pena 777, Buenos Aires, Argentina, S. A. . . . . '40
Brace, Orval L., 803 Second Natl. Bank Bldg., Houston, Tex. . . . . '19
‖Bradbury, Albert E., Flying Cadet Detachment, Lowry Field, Denver, Colo. . . . . '41
Bradfield, Herbert H., The Texas Co., Box 1720, Fort Worth, Tex. . . . . '27
Bradford, Charles E., The California Co., 700 Lancaster Bldg., Calgary, Alta., Canada . . . . . '37
Bradish, Beverly B., Carter Oil Co., Box 801, Tulsa, Okla. . . . . '37
Bradish, Ford, independent, 2005 Fort Worth Natl. Bank Bldg., Fort Worth, Tex. . '19
Bradley, Everett L., c/o Bradley Bros., 1115 Bitting Bldg., Wichita, Kan. . . . . '22
Braendlin, E., Speiserstrasse 89, Basle, Switzerland. . . . . '32
Brainerd, Arthur E., Continental Oil Co., Denver, Colo. . . . . '22
Bramkamp, R. A., California Standard Arabian Oil Co., Bahrein Island, Persian Gulf. . . . . '40
Bramlette, Milton N., Dept. of Geology, Univ. of California, W. Los Angeles, Calif. . '25
Bramlette, William A., Dept. of Geology, Univ. of Texas, Austin, Tex. . . . . '37
Brankstone, Hugh R., Gulf Oil Corp., 3332 Gulf Bldg., Pittsburgh, Pa. . . . . '32
Branner, George C., 446 State Capitol Bldg., Little Rock, Ark. . . . . '21
Branson, Carl C., Dept. of Geology, Univ. of Kentucky, Lexington, Ky. . . . . '40
‖Branson, Delmar O., Stanolind Oil & Gas Co., Box 661, Midland, Tex. . . . . '41
Branson, E. B., 101 Swallow Hall, Columbia, Mo. . . . . '25
Branson, E. R., Carter Oil Co., Box 568, Mattoon, Ill. . . . . '38

Brant, Ralph A., Atlantic Refg. Co., 510 Beacon Bldg., Tulsa, Okla.....'26
Brantly, John E., Drilling & Expl. Co., Box 2, Station H, Los Angeles, Calif.....'18
Brauchli, R. W., Anderson-Prichard Oil Corp., 909 Ramsey Tower, Oklahoma City, Okla.....'23
Braugh, Donald D., Sun Oil Co., San Jacinto Bldg., Beaumont, Tex.....'21
Braunstein, Jules, Shell Oil Co., Inc., 805 Slattery Bldg., Shreveport, La.....'37
Bravinder, Kenneth M., Union Oil Co. of Calif., Box 511, Compton, Calif.....'37
Bray, Vinton A., Colombian Petr. Co., Apt. 100, Cucuta, Colombia, S. A.....'41
Brazil, James J., Kansas State Board of Health, Box 41, Russell, Kan.....'41
Brecke, Ervin A., Mahoning Mining Co., Box 335, Rosiclare, Ill.....'41
‖Breed, Edgar R., Jr., U. S. Naval Reserve, Submarine Base, New London, Conn...'39
Brehm, C. E., Box 502, Mt. Vernon, Ill.....'37
Breitenstein, Robert S., c/o Ultramar S.A.P.A., Avda. N. de Alem 619, Buenos Aires, Argentina, S. A.....'29
Bremer, Bernhard E., The Texas Co., Box 252, New Orleans, La.....'30
Bremner, Carl St. J., Caltex (Australia) Oil Development Pty., Ltd., Box 1593-BB, G.P.O., Sydney, N. S. W., Australia.....'23
Brewer, Charles, Jr., Godfrey L. Cabot, Inc., Box 348, Charleston, W. Va.....'27
‖Briard, Vernon E., The Texas Co., Box 2332, Houston, Tex.....'37
Brice, John W., Standard Oil Co. of Venezuela, Caracas, Venezuela, S. A.....'28
‖Bricker, John F., Humble Oil & Refg. Co., Houston, Tex.....'36
‖Brier, Ervin E., Continental Oil Co., Midland, Tex.....'42
Briggs, Colver R., Bur. of Power & Light, Box 3669, Terminal Annex, Los Angeles, Calif.....'38
Bright, Richard T., Mercantile Natl. Bank, Dallas, Tex.....'23
Brillhart, Norman W., Box 654, Madill, Okla.....'28
Brinkerhoff, Ira A., Standard Oil Co. (Indiana), Rm. 1940, 910 S. Michigan Ave., Ave., Chicago, Ill.....'29
Briscoe, Glenn O., c/o Cornwell, Inc., 4 N. Eighth St., St. Louis, Mo.....'22
‖Bristley, L. P., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa.....'39
‖Bristol, Hubert M., The Ohio Oil Co., Marshall, Ill.....'41
‖Britt, Harry M., Jr., 809 Jackson St., Amarillo, Tex.....'41
Brock, Stephen W., Jr., Pure Oil Co., Box 671, Midland, Tex.....'30
Brockway, E. R., Box 546, Marksville, La.....'24
‖Brodie, Gerson H., 175 Riverside Dr., New York, N. Y.....'39
Broedel, Carl Huntington, Anaconda Copper Mining Co., Stillwater Mine, Nye, Mont.....'41
Brokaw, Albert D., c/o Brokaw, Dixon & McKee, 120 Broadway, New York, N. Y...'22
Brokaw, John M., Jr., Pure Oil Co., Box 239, Houston, Tex.....'40
Brooks, Benton S., Jr., Shell Oil Co., Inc., Box 218, Great Bend, Kan.....'39
Brooks, Frank M., Gulf Refg. Co., Box 106, Indianapolis, Ind.....'36
Brooks, Olin D., Humble Oil & Refg. Co., Dallas, Tex.....'30
Brossard, Eugene E., Mene Grande Oil Co., Apt. 709, Caracas, Venezuela, S. A...'35
Broughton, M. N., The Texas Co., Box 951, Houma, La.....'33
Broussard, David F., Independent Expl. Co., 2011 Esperson Bldg., Houston, Tex...'38
‖Broussard, Lloyd J., 824 Esperson Bldg., Houston, Tex.....'38
Brouwer, L. E. J., Bataafsche Petr. Mij., Hoofdvertegenwoordiging, Batavia, N. E. I.....'38
Brown, Augustus Bart, Mudge Oil Co., 1500 Gulf States Bldg., Dallas, Tex.....'37
Brown, H. Travis, I. T. I. O. Co., Box 4577, Capitol Hill Station, Oklahoma City, Okla.....'36
Brown, Harry J., producer, 640 W. Fourteenth St., Tulsa, Okla.....'25
Brown, Ira Otho, 1011 Milam Bldg., San Antonio, Tex.....'24
Brown, J. Albert, Kentucky Nat. Gas. Co., Owensboro, Ky.....'39
Brown, J. Earle, consultant, 807 Trinity Life Bldg., Fort Worth, Tex.....'20
Brown, James Chapman, Blairfordel, 31 Balgreen Rd., Edinburgh, Scotland.....'27
Brown, Merritt H., Darby Petr. Corp., Philtower Bldg., Tulsa, Okla.....'29
Brown, Otto E., Gulf Refg. Co., Box 482, Mattoon, Ill.....'31
Brown, Prentice F., Honolulu Oil Corp., Box 1391, Midland, Tex.....'29
Brown, Robert, Mudge Oil Co., Box 4059, Shawnee, Okla.....'30
Brown, Robert Wesley, Dept. of Geology, St. Lawrence Univ., Canton, N. Y.....'20
Brown, Samuel B., consulting, 5812 Harrisburg Blvd., Houston, Tex.....'29

‖Brown, Silas C., Socony-Vacuum Oil Co., Apt. Nac. 1140, Bogota, Colombia, S. A..'41
Brown, Vergil N., 1614 N. W. Sixteenth St., Oklahoma City, Okla.....'23
Brown, William F., consulting, Box 302, Mt. Pleasant, Mich.....'30
Browne, Richard Vernon, Iraq Petr. Co., Ltd., Box 309, Haifa, Palestine.....'38
Browning, Iley B., consulting, Box 126, Ashland, Ky.....'21
Bruce, George H., 705 Ellis Singleton Bldg., Wichita, Kan.....'25
Brundall, Laurence, Shell Oil Co., Inc., Box 2037, Tyler, Tex.....'36
Bruyere, Alan, The Texas Co., Box 2332, Houston, Tex.....'19
Bryan, Carl L., Gulf Research & Dev. Co., Drawer 2038, Pittsburgh, Pa.....'37
Bryan, Frank, Nelson, Okla.....'19
Bryan, Joseph J., Tide Water Assoc. Oil Co., Rt. 1, Box 197-X, Bakersfield, Calif...'41
Bryant, Howard S., Skelly Oil Co., Box 1650, Tulsa, Okla.....'27
Buchanan, George S., c/o Buchanan & Harrington, 1524 Esperson Bldg., Houston, Tex.....'25
‖Bucher, J. Eric, The Ohio Oil Co., Midland, Tex.....'39
Buchner, Carl F., 118 Portland Terrace, Webster Groves, Mo.....'26
Buchner, Harry M., Carter Oil Co., Drawer 1739, Shreveport, La.....'41
‖Buck, Charles E., 816 E. Sixteenth St., Falls City, Neb.....'39
Buck, Cleo Eugene, Humble Oil & Refg. Co., Box 711, Corpus Christi, Tex.....'35
Buck, E. O., 1632 Commerce Bldg., Houston, Tex.....'27
Buck, Loren I., consulting, 338 N. Parkwood Lane, Wichita, Kan.....'35
‖Buck, Nina M., 2739 Talbot, Houston, Tex.....'42
Buckstaff, Sherwood, Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'27
‖Budd, Montgomery R., Hercules Powder Co., Wilmington, Del.....'41
Buddenhagen, H. J., 200 N. Robinson St., Los Angeles, Calif.....'31
Buehler, H. A., Missouri Geol. Survey, Rolla, Mo.....'21
Buehner, John Hubert, The Ohio Oil Co., McLeansboro, Ill.....'40
Bugbee, J. M., National Lead Co., Baroid Sales Dept., Houston, Tex.....'40
Buie, Bennett Frank, 1914 Chacon St., Laredo, Tex.....'38
Bullard, Edgar F., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla.....'23
Bullard, Fred M., Dept. of Geology, Univ. of Texas, Austin, Tex.....'20
Bundy, Douglas, M. H. Whittier Co., Ltd., Los Angeles, Calif.....'39
Bunn, John R., Cherokee Prod. Co., 310 Blackstone Bldg., Tyler, Tex.....'26
‖Bunsen, A. W., Adams Oil & Gas Co., 2305 Esperson Bldg., Houston, Tex.....'38
Bunte, Arnold S., Vickers Petr. Co., Wichita, Kan.....'26
Burbridge, C. E., Jr., c/o Cia Minera di Penoles, Apt. 251, Monterrey, N. L., Mex.....'34
‖Burchard, Frederic L., c/o DeGolyer, MacNaughton & McGhee, Continental Bldg., Dallas, Tex.....'39
Burchfiel, Hugh L., Standard Oil Co. of Texas, Petroleum Bldg., Houston, Tex....'23
Burford, Selwyn O., Rt. 2, Box 270-C, Tyler, Tex.....'26
Burger, Robert W., The Texas Co., Rm. 8, Kern Co. Land Bldg., Bakersfield, Calif..'30
‖Burgess, V. N., 1533 W. Colorado, Dallas, Tex.....'40
Bürgl, Hans, Gewerkschaft Austrogasco, Schwarzenbergplatz 18, Wien 1, Germany.'40
‖Burke, James D., Seaboard Oil Co., Driscoll Bldg., Corpus Christi, Tex.....'38
Burkhead, W. Z., Union Oil Co. of Calif., 1134 Commerce Bldg., Houston, Tex...'37
Burling, Lancaster D., State Mineral Survey, 92 Mitchell St., S. W., Atlanta, Ga...'24
Burnett, Jerome B., Vacuum Oil Co. Pty., Ltd., 29 Market St., Melbourne, Australia'18
Burnett, T. J., Humble Oil & Refg. Co., Box 2025, Tyler, Tex.....'30
Burnham, Roderick D., Burnham Expl. Co., Union Oil Bldg., Los Angeles, Calif...'27
Burns, R. W., Union Oil Co. of Calif., Kern Co. Land Bldg., Bakersfield, Calif...'39
Burress, George Howard, 2511 Ramsey Tower, Oklahoma City, Okla.....'19
Burress, Walter M., Box 387, Dallas, Tex.....'20
Burt, Roy A., Burlington Oil Co., 1101 Burlington Ave., N. Kansas City, Mo.....'20
Burton, George E., Sun Oil Co., Box 807, Tyler, Tex.....'17
Burtt, John G., Shell Oil Co., Inc., 508 Shell Bldg., Los Angeles, Calif.....'19
Bush, Frederic A., Sinclair Prairie Oil Co., Tulsa, Okla.....'31
‖Bush, Robert Ewell, Btry. C-31 Bn., F.A.R.T.C., Fort Sill, Okla.....'41
Butcher, Cary P., Box 331, Midland, Tex.....'24
Butcher, S. D., Rocket Drilling Co., 609 Orpheum Bldg., Wichita, Kan.....'21
Butler, John W., Jr., Texas Petr. Co., Apt. Postal 877, Bogota, Colombia, S. A...'39
Butt, William H., Atlantic Refg. Co., 510 Beacon Bldg., Tulsa, Okla.....'32

Buttermore, Paul M., consulting, Box 131, E. Lansing, Mich. . . . . '27
Butters, Roy M., Tennessee Valley Authority, McKinney Bldg., Columbia, Tenn. . . '21
Butterworth, E. M., Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif. . '21
Buttram, Frank, 2909 First Natl. Bank Bldg., Oklahoma City, Okla. . . . . '18
Buttram, William A., independent, Rt. 2, Puente, Calif. . . . . '22
Buwalda, John P., California Inst. of Technology, Pasadena, Calif. . . . . '26
Bybee, Hal P., University Lands, Box 2101, Univ. Station, Austin, Tex. . . . . '19
‖Bybee, Halbert Homer, 1500 Marshall Ave., Evansville, Ind. . . . . '40
‖Bybee, Robert William, Humble Oil & Refg. Co., 1406 Canal Bldg., New Orleans, La. . . . . '41
‖Byers, J. W., McCollum Expl. Co., 611 Esperson Bldg., Houston, Tex. . . . . '37
Byram, John P., Sandy Ridge Oil Co., 609 West Texas Utilities Bldg., Abilene, Tex. . '38
Byram, R. W., c/o R. W. Byram & Co., Drawer M, Capitol Station, Austin, Tex. . . '24
Byrd, David Harold, Byrd-Frost, Inc., 1110 Tower Petroleum Bldg., Dallas, Tex. . . '27

Cahill, Edgar D., Skelly Oil Co., Box 726, Evansville, Ind. . . . . '29
Calahan, Luther Weldon, The Texas Co., Box 457, New Iberia, La. . . . . '38
Callahan, Drury V., c/o Westheimer & Daube, Ardmore, Okla. . . . . '26
Calohan, William F., 2044 Addison, Houston, Tex. . . . . '31
‖Calvert, Warren L., The Ohio Fuel Supply Co., Fairfield, Ill. . . . . '39
‖Camp, John F., Jr., 1103 Natl. Bank of Commerce Bldg., San Antonio, Tex. . . . . '38
Camp, Richard W., Consolidated Gas Utilities Corp., 1004 Braniff Bldg., Oklahoma City, Okla. . . . . '30
Campbell, F. F., 2416 Arbor St., Houston, Tex. . . . . '34
Campbell, Harry A., Jergins Oil Co., 1000 Jergins Trust Bldg., Long Beach, Calif. . '25
Campbell, Ian, Dept. of Geology, California Inst. of Technology, Pasadena, Calif. . '26
Campbell, J. L. P., Lane-Wells Co., Box 1088, El Dorado, Ark. . . . . '39
Campbell, John M., Box 278, Laredo, Tex. . . . . '31
Campbell, Robert B., 1321 Memorial Highway, Tampa, Fla. . . . . '23
Campbell, William R., Stanolind Oil & Gas Co., Box 3092, Houston, Tex. . . . . '38
‖Campo, Henry Andrew, Box 169, Shawnee, Okla. . . . . '41
Canada, W. R., Stanolind Oil & Gas Co., Lake Charles, La. . . . . '36
Canfield, Charles R., Stanolind Oil & Gas Co., Midland, Tex. . . . . '35
Cannan, Morris, Midstates Oil Corp., Alice, Tex. . . . . '41
Cannon, Joe, c/o Cannon & Cannon, 809 McBurnett Bldg., San Angelo, Tex. . . . . '28
Cannon, R. L., c/o Cannon & Cannon, 809 McBurnett Bldg., San Angelo, Tex. . . '23
Canon, Joe, Gulf Oil Corp., Box 1290, Fort Worth, Tex. . . . . '38
Cantrell, Ralph B., Sul Ross Court, South #8, Houston, Tex. . . . . '40
Cardwell, D. Harold, Sun Oil Co., Box 807, Tyler, Tex. . . . . '30
‖Cardwell, William Henry, Seaboard Oil Co., 506 Driscoll Bldg., Corpus Christi, Tex. . . . . '39
Carey, Hillard W., 2510 Gulf Bldg., Houston, Tex. . . . . '36
Carey, S. Warren, Australasian Petr. Co., Port Moresby, Papua . . . . . '36
Carlson, Charles G., consulting, 922 Thompson Bldg., Tulsa, Okla. . . . . '24
Carlson, Edwin N., producer, 500 Bitting Bldg., Wichita, Kan. . . . . '24
Carlton, Dave P., Humble Oil & Refg. Co., 901 Humble Bldg., Houston, Tex. . . . . '20
Carman, Katharine W., 215 N. Gardner St., West Frankfort, Ill. . . . . '36
Carmody, Robert A., Gulf Oil Corp., 1107 Union Natl. Bank Bldg., Wichita, Kan. . . '36
Carpenter, Charles B., U. S. Bur. Mines, 551 Federal Bldg., Dallas, Tex. . . . . '34
Carpenter, Everett, consulting, 2017 N. Market St., Shawnee, Okla. . . . . '21
Carpenter, E. Gail, consulting, 240 N. Pinecrest, Wichita, Kan. . . . . '26
Carpenter, M. E., consulting, 344 Key Bldg., Oklahoma City, Okla. . . . . '25
Carr, George W., General Geophysical Co., 2513–14 Gulf Bldg., Houston, Tex. . . '26
Carsey, J. Ben, Humble Oil & Refg. Co., 1405 Canal Bldg., New Orleans, La. . . . . '26
Carter, Charles William, Illinois Geol. Survey, Urbana, Ill. . . . . '39
‖Carter, Devere V., Magnolia Petr. Co., Box 900, Dallas, Tex. . . . . '28
Carter, G. R., Gulf Oil Corp., Box 1150, Midland, Tex. . . . . '37
‖Cartmell, William M., 405 S. Clay, Taylorville, Ill. . . . . '42
Cartwright, Lon D., Jr., Union Oil Co. of Calif., Houston, Tex. . . . . '24
Cartwright, Weldon E., Tide Water Assoc. Oil Co., 809 Giddens-Lane Bldg., Shreveport, La. . . . . '35
Case, Leslie C., Gulf Oil Corp., Box 661, Tulsa, Okla. . . . . '26

Case, William B., Shell Oil Co., Inc., 50 W. Fiftieth St., New York, N. Y.....'22
‖Casey, S. Russel, Jr., Woodley Petr. Co., Box 1403, Houston, Tex.....'38
Cash, Thornton C., Humble Oil & Refg. Co., Tyler, Tex.....'23
Cashin, D'Arcy M., 705 Natl. Standard Bldg., Houston, Tex.....'19
Cassel, Chester, The Texas Co., 929 S. Broadway, Los Angeles, Calif.....'30
Cassingham, Robert L., Amerada Petr. Corp., Box 896, Shawnee, Okla.....'27
Casteel, S. H., Landreth Prod. Corp., Box 2077, Fort Worth, Tex.....'30
Caster, E. L., Arkansas Nat. Gas Corp., Shreveport, La.....'28
Caster, Kenneth E., Geol. Dept., Univ. of Cincinnati, Cincinnati, Ohio.....'36
‖Cathcart, James B., Jr., 4846 Seventh St., San Francisco, Calif.....'41
‖Catinari, Altavino E., Y. P. F., Klm. 3, Chubut, Argentina, S. A.....'40
Caudri, Cornelie Marguerite Bramine, Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B. W. I.....'41
Cave, Harold S., Box 485, Roswell, N. Mex.....'23
Caylor, Garth W., Shell Oil Co., Inc., Evansville, Ind.....'38
‖Cederstrom, D. John, U. S. Geol. Survey, Charlottesville, Va.....'41
Cerkel, J. David, Jr., U. S. Geological Survey, Bin CC, Taft, Calif.....'36
Cesinger, E. F., 512 Continental Bldg., Dallas, Tex.....'27
Chaddick, W. M., Jr., Plano, Tex.....'35
Chambers, Jack, Phillips Petr. Co., 522 Esperson Bldg., Houston, Tex.....'38
Chambers, L. S., Seaboard Oil Co. of Delaware, Rm. 970, 417 S. Hill St., Los Angeles, Calif.....'42
‖Champion, Joe A., Standard Oil Co. of Venezuela, Apt. 1329, Caracas, Venezuela, S. A.....'39
Champion, Oscar R., Amerada Petr. Corp., Box 591, Midland, Tex.....'30
Chapell, D. O., Transwestern Oil Co., 1600 Milam Bldg., San Antonio, Tex.....'36
Chapin, Theodore, 1938 California St., San Marino, Calif.....'23
Chapman, M. E., Chemical Process Co., 312 Thompson Bldg., Tulsa, Okla.....'39
‖Chapman, R. T., Stanolind Oil & Gas Co., Box 1092, Shreveport, La.....'40
Chappell, Walter M., Texas Petr. Co., Apt. Postal 159, Barranquilla, Colombia, S. A.....'40
Chappius, Louis C., consulting, 950 S. Broadway, Los Angeles, Calif.....'27
Charles, Homer H., Phillips Petr. Co., Bartlesville, Okla.....'25
Charrin, P., Schlumberger Well Surveying Corp., Box 2175, Houston, Tex.....'28
‖Chase, C. Louis, The Texas Co., Box 1270, Midland, Tex.....'40
Chase, James L., Olympic Refg. Co., 2425 California Ave., Long Beach, Calif.....'22
‖Chase, William L., 4337 E. Second St., Long Beach, Calif.....'40
Chasey, Kenneth L., The Texas Co., Mattoon, Ill.....'40
Chawner, William D., Carter Oil Co., Box 1490, Jackson, Miss.....'29
Cheney, M. G., Anzac Oil Corp., Coleman, Tex.....'19
Cheyney, Alvin E., The Ohio Oil Co., Box 266, Falls City, Neb.....'21
Childerhose, Allen J., The Texas Co., Box 2332, Houston, Tex.....'30
‖Childs, T. S., Jr., Box 71, Riverside, Calif.....'41
‖Chilton, James Ryder, Claresholm, Alta., Canada.....'41
Christensen, H. E., The Texas Co., Box 2100, Denver, Colo.....'29
Christenson, A. C., 516 N. Hancock Ave., Colorado Springs, Colo.....'40
Christie, Laurence G., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'25
Christie, Robert S., Amerada Petr. Corp., Box 1348, Fort Worth, Tex.....'25
Christner, D. D., Continental Oil Co., Box 2200, Fort Worth, Tex.....'24
Chun, H. A., Texas Gulf Prod. Co., Box 322, Mont Belvieu, Tex.....'38
Church, Charles R., Jr., Humble Oil & Refg. Co., 256 Humble Bldg., Houston, Tex..'31
Church, Clifford C., Tide Water Assoc. Oil Co., 79 New Montgomery St., San Francisco, Calif.....'30
Claiborne, Ray E., 2204 N. Everest, Oklahoma City, Okla.....'38
Clair, Joseph R., Dept. of Geology, De Pauw Univ., Greencastle, Ind.....'41
Clapp, F. G., 50 Church St., New York, N. Y.....'18
Clark, Alexander, Shell Oil Co., Inc., 1008 W. Sixth St., Los Angeles, Calif.....'36
Clark, Bruce L., Hearst Mining Bldg., Univ. of California, Berkeley, Calif.....'27
Clark, Charles K., Pure Oil Co., Goshen, Ind.....'37
Clark, Chester C., Union Prod. Co., Box 1407, Shreveport, La.....'19
Clark, Clare M., I. T. I. O. Co., Box 1251, Bartlesville, Okla.....'28
Clark, Frank Rinker, The Ohio Oil Co., Box 981, Tulsa, Okla.....'20

Clark, Frank T., Cities Service Oil Co., Box 2832, Odessa, Tex.....'23
Clark, G. C., Stanolind Oil & Gas Co., 918 Oliver Eakle Bldg., Amarillo, Tex.....'31
Clark, George H., The Texas Co., New Orleans, La.....'33
Clark, Glenn C., Continental Oil Co., Ponca City, Okla.....'19
Clark, Harold J., Conservation Committee of Calif. Operators, 1160 Subway Terminal Bldg., Los Angeles, Calif.....'41
Clark, Howard, Bryan Petr. Co., Beacon Bldg., Tulsa, Okla.....'23
Clark, H. Smith, Sinclair Prairie Oil Co., Box 1990, Fort Worth, Tex.....'22
‖Clark, James E., The Ohio Oil Co., Box 266, Falls City, Neb.....'41
Clark, J. Tate, Phillips Petr. Co., 703–11 Driscoll Bldg., Corpus Christi, Tex.....'39
Clark, John W., Magnolia Petr. Co., Box 900, Dallas, Tex.....'27
Clark, Joseph Marsh, Tide Water Assoc. Oil Co., Philcade Bldg., Tulsa, Okla.....'29
Clark, L. W., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'29
Clark, Leslie M., Shell Oil Co., Inc., Centralia, Ill.....'26
Clark, Paul H., Box 57, La Ward, Tex.....'41
Clark, Robert P., Phillips Petr. Co., Bartlesville, Okla.....'27
Clark, Robert S., Skelly Oil Co., 510 Ellis-Singleton Bldg., Wichita, Kan.....'37
Clark, Robert W., Western Gulf Oil Co., 1260 Subway Terminal Bldg., Los Angeles, Calif.....'18
Clark, Stuart K., Continental Oil Co., Ponca City, Okla.....'19
‖Clark, William A., Michigan Elevation Service, Box 192, Mt. Pleasant, Mich.....'40
Clark, William A., Jr., Schlumberger Well Surveying Corp., Box 2175, Houston, Tex.'26
Clark, W. Kenley, Superior Oil Co., Oil & Gas Bldg., Houston, Tex.....'36
‖Clarke, Ralph L., Gulf Oil Corp., Box 661, Tulsa, Okla.....'42
Clarke, Robert L., Union Oil Co., 1214 Petroleum Bldg., Midland, Tex.....'40
Clarkson, William George, Jr., The Ohio Oil Co., Box 819, Midland, Tex.....'38
Classen, Willard J., R. F. D., Box 330-D, Redwood City, Calif.....'23
Clawson, Willard W., Magnolia Petr. Co., Box 900, Dallas, Tex.....'25
Clay, Withers, consulting, Box 86, Carmi, Ill.....'26
Claypool, C. B., Sun Oil Co., Box 2831, Beaumont, Tex.....'30
Clayton, Edgar H., Drilling & Expl. Co., Inc., Caixa Postal 470, Baia, Brazil, S. A...'39
Clement, George M., The Texas Co., Box 252, New Orleans, La.....'34
Clement, Paul F., Box 627, Fresno, Calif.....'39
Clifford, O. C., Jr., Atlantic Refg. Co., Box 1346, Houston, Tex.....'28
Clifton, R. L., 1703 E. Maple St., Enid, Okla.....'25
Clinkscales, Albert S., 904 Colcord Bldg., Oklahoma City, Okla.....'19
Closuit, E. M., producer, 1904 Alamo Natl. Bldg., San Antonio, Tex.....'22
‖Clote, Thomas A., Sunray Oil Co., Philtower Bldg., Tulsa, Okla.....'41
Cloud, Wilbur F., Univ. of Oklahoma, Faculty Exchange, Box 343, Norman, Okla..'37
Clowe, Charles E., Box 927, Throckmorton, Tex.....'23
Clute, Walker S., consulting, 811 W. Seventh St., Los Angeles, Calif.....'41
Coates, George H., 638 Milam Bldg., San Antonio, Tex.....'26
Cobb, Margaret C., 270 Seaman Ave., New York, N. Y.....'26
‖Cobban, William A., Carter Oil Co., Box 358, Bismarck, N. Dak.....'41
Cochran, Phil K., Standard Oil Co. of La., Drawer 1739, Shreveport, La.....'23
Coel, E. J., Gulf States Oil Co., Box 397, Mercedes, Tex.....'27
Coenen, Edward J., General Petr. Corp., Box D, Taft, Calif.....'39
Coffin, R. Clare, Stanolind Oil & Gas Co., Box 591, Tulsa, Okla.....'26
Cogen, William M., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'37
Cohee, George V., Illinois Geol. Survey, Urbana, Ill.....'37
Coil, Fay, Box 510, Midland, Tex.....'30
Coldwell, Charles H., Sun Oil Co., 830 Milam Bldg., San Antonio, Tex.....'37
Cole, Adna Malone, Box 42, Coudersport, Pa.....'40
Cole, Charles Taylor, University Lands, Box 1663, Midland, Tex.....'37
Cole, Edwin G., Sinclair Wyoming Oil Co., Box 808, Evansville, Ind.....'25
‖Cole, John Gordon, Expl. Dept., Union Pacific Ry., 422 W. Sixth St., Los Angeles, Calif.....'37
Cole, Virgil B., Gulf Oil Corp., 1107 Union Natl. Bank Bldg., Wichita, Kan.....'24
Coleman, Tom L., U. S. Geol. Survey, Box 976, Oklahoma City, Okla.....'24
‖Colle, Jack Overton, consulting, 1658 W. Main, Apt. 7, Houston, Tex.....'39
Collett, J. Daviss, Jr., 1912 W. Gray, Houston, Tex.....'38
Colley, Bernard B., Tropical Oil Co., Depto. de Santander, El Centro, Colombia, S. A.....'38

‖Collier, John J., Pure Oil Co., Box 239, Houston, Tex.....'41
Collingwood, D. M., Sun Oil Co., Box 2880, Dallas, Tex.....'21
‖Collins, Burton Wallace, New Zealand Petr. Co., Box 295, Gisborne, N. Z.....'39
Collins, C. Philip, Eastman Oil Well Survey Co., Box 5298, Dallas, Tex.....'25
Collom, Roy E., Continental Oil Co., 601 W. Fifth St., Los Angeles, Calif.....'19
Colton, Earl G., 937 Milam Bldg., San Antonio, Tex.....'29
Colton, Howard F., 937 Milam Bldg., San Antonio, Tex.....'36
Combs, Edward J., Sun Oil Co., Old Natl. Bank Bldg., Evansville, Ind.....'39
Condit, D. Dale, Standard Vacuum Oil Co., 26 Broadway, New York, N. Y.....'21
‖Conger, Lauren Tenney, Pure Oil Co., Box 671, Midland, Tex.....'38
Conhaim, Howard J., consulting, 1638 E. Seventeenth Pl., Tulsa, Okla.....'39
Conkling, R. A., consulting, 904 Colcord Bldg., Oklahoma City, Okla.....'17
Conkling, Russell C., independent consultant, Box 1704, Midland, Tex.....'22
Conley, J. N., Box 1782, Midland, Tex.....'35
‖Conrad, Charles S., 1408 Esperson Bldg., Houston, Tex.....'29
‖Conrad, Peter Paul, Socony-Vacuum Oil Co. C. A., Apt. 246, Caracas, Venezuela, S. A.....'41
Conselman, Frank B., Gulf Oil Corp., Wichita, Kan.....'36
‖Conway, W. P., Jr., Blue Mill Rd., Green Village, N. J.....'39
‖Conwell, Cleland N., 1337 Gaylord St., Denver, Colo.....'40
Cook, Carroll E., 506 W. Twenty-second St., Austin, Tex.....'22
Cooke, E. E., Box 209, Thibodaux, La.....'38
‖Cooke, H. C., La Porte, Tex.....'41
Cooley, Ralph S., c/o George P. Livermore, Inc., First Natl. Bank Bldg., Midland, Tex.....'38
Cooper, C. Harrison, Headq. Btry., 57th F. A. Bn., E. Garrison, 7th Div., Fort Ord, Calif.....'37
Cooper, Herschel H., consulting, 1015 Milam Bldg., San Antonio, Tex.....'25
‖Cooper, James Blair, U. S. Geol. Survey, Box 608, Russell, Kan.....'41
Cooper, Russell C., Sinclair Wyoming Oil Co., 620 Court Bldg., Evansville, Ind.....'38
Copass, Jack M., Amerada Petr. Corp., Box 995, Wichita, Kan.....'27
Copeland, Richard G., 723 W. Main, Magnolia, Ark.....'27
Copeland, Robert R., Jr., The California Co., 1818 Canal Bank Bldg., New Orleans, La.....'37
Corbett, Clifton S., Socony-Vacuum Oil Co., 26 Broadway, Rm. 1135, New York, N. Y.....'19
Corbin, Milton W., Skelly Oil Co., 419 Ardis Bldg., Shreveport, La.....'38
Corby, Grant W., Box 2540, Manila, P. I.....'26
Cordry, C. D., Gulf Oil Corp., Box 1290, Fort Worth, Tex.....'29
Corey, George Simpson, Shell Oil Co., Inc., Box 1509, Midland, Tex.....'40
Corey, William Henry, 4431 Firmament Ave., Encino, Calif.....'32
Corman, Hyman, Plymouth Oil Co., Midland, Tex.....'37
‖Cornelius, Lee H., Pure Oil Co., Box 271, Tulsa, Okla.....'41
Cornell, Lee H., Stanolind Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan.....'27
Corning, Leavitt, Jr., consulting, 1733 Milam Bldg., San Antonio, Tex.....'30
Cortes, Henry C., Magnolia Petr. Co., Box 900, Dallas, Tex.....'30
Cortright, William D., Tide Water Assoc. Oil Co., R. 1. Box 197–B, Bakersfield, Calif.....'34
Coryell, Horace N., Columbia University, New York, N. Y.....'26
Coryell, Lewis S., Cities Service Oil Co., 824 Hamilton Bldg., Wichita Falls, Tex.....'20
Coryn, F. R., The Texas Co., Box 2420, Tulsa, Okla.....'30
Costa, Delbert J., Pryor & Lockhart, Inc., 320 Union Natl. Bank Bldg., Wichita, Kan.....'38
Cotner, Victor, Columbian Carbon Co., 41 E. Forty-second St., New York, N. Y.....'27
Cottingham, Virgil E., 1119 Monte Cito Dr., San Antonio, Tex.....'21
Cotulla, R. E., consulting, Milam Bldg., San Antonio, Tex.....'26
Courtier, William H., Geophysical Dept., Phillips Petr. Co., Bartlesville, Okla.....'28
Couser, C. W., Carter Oil Co., Box 1151, Seminole, Okla.....'36
Cox, Benjamin Burton, Socony-Vacuum Oil Co., Inc., Rm. 1141, 26 Broadway, New York, N. Y.....'26
Cox, Harris, Western Geophysical Co., 902 Mellie Esperson Bldg., Houston, Tex.....'39
‖Cox, H. Mack, Phillips Petr. Co., 1009 Giddens-Lane Bldg., Shreveport, La.....'40
Cox, Robert T., Atlantic Refg. Co., Box 871, Midland, Tex.....'37

Cox, W. Philip, 7705 Military Dr., Dallas, Tex.....'38
Craig, Eric K., 216 W. Frances Willard Ave., Chico, Calif.....'28
Craig, T. C., Phillips Petr. Co., Box 1751, Amarillo, Tex.....'31
Cram, Edward C., Magnolia Petr. Co., Box 1406, Shreveport, La.....'39
Cram, Ira H., Pure Oil Co., 35 E. Wacker Dr., Chicago, Ill.....'26
Crandall, Kenneth H., 77 Audubon Blvd., New Orleans, La.....'23
Crandall, Richard R., 5034 Alta Canyada Rd., La Canada, Calif.....'24
Crandall, Roderic, Box 269, Glendale, Calif.....'24
Cranson, Lorin A., Honolulu Oil Corp., 215 Market St., San Francisco, Calif.....'29
Crawford, David J., consulting, 3915 Northwood Rd., Dallas, Tex.....'27
Crawford, F. W., Phillips Petr. Co., Bartlesville, Okla.....'40
‖Crawford, Gayle P., 923 Ridge, Houston, Tex.....'41
Crawford, James Gilmore, U. S. Dept. of the Interior, Federal Bldg., Casper, Wyo..'39
Crays, Glenn E., Texas Pacific Coal & Oil Co., Box 393, Midland, Tex.....'37
‖Creasey, Saville Cyrus, 848 E. Kensington Rd., Los Angeles, Calif.....'40
Crebbs, Chester M., Mene Grande Oil Co., Apt. 709, Caracas, Venezuela, S. A..'22
Crickmay, Geoffrey W., Puerto Cabezas, Nicaragua.....'41
Crider, Albert F., independent, 1212 City Bank Bldg., Shreveport, La.....'22
‖Crider, Lewis, C., 1907 Fifteenth St., Lubbock, Tex.....'39
Croneis, Carey, Walker Museum, Univ. of Chicago, Chicago, Ill.....'29
Cronin, K. Stewart, Pure Oil Co., Box 271, Tulsa, Okla.....'35
Crook, Theo H., c/o W. B. Thomas, 6699 Telegraph Ave., Oakland, Calif.....'24
‖Crosby, Arthur S., 8101 West Blvd., Inglewood, Calif.....'28
‖Crosby, George E., Stanolind Oil & Gas Co., Box 461, Iraan, Tex. (Last address)..'40
Cross, Rodman K., Richfield Oil Corp., 740 E. Palm Dr., Orange, Calif.....'37
Crow, L. M., Crow Drilling Co., 422 Commercial Natl. Bank Bldg., Shreveport, La..'39
‖Crowell, John C., 450 University Circle, Claremont, Calif.....'41
Crowell, John H., 3416 Ella Lee Lane, Houston, Tex.....'39
Crowl, G. H., Dept. of Geology, Princeton Univ., Princeton, N. J.....'36
Crum, Harry E., Columbian Carbon Co., 41 E. Forty-second St., New York, N. Y..'23
‖Crumley, R. F., Jr., Geol. Dept., Phillips Petr. Co., Bartlesville, Okla.....'42
Crump, John R., Gulf Oil Corp., Box 1150, Midland, Tex.....'38
Cruse, John S., Jr., Amerada Petr. Corp., Houston, Tex.....'26
Culbertson, J. Archer, Continental Oil Co., Box 3126, Houston, Tex.....'38
Cullen, Albert William, Continental Oil Co., 1024 Continental Bldg., Denver, Colo..'40
Cullen, Ronald J., Sun Oil Co., Box 1348, Tulsa, Okla.....'23
Culver, Harold E., State College of Washington, Pullman, Wash.....'24
Cumming, Alfred, c/o Cumming Oil Co., Inc., Tulsa, Okla.....'24
Cummins, R. H., c/o Cummins & Berger, Trinity Life Bldg., Fort Worth, Tex..'21
Cunningham, Carleton J., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex..'29
Cunningham, George M., Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif.....'24
Curry, William H., Wellington Oil Co., 1108 S. Texas Bank Bldg., San Antonio, Tex.....'28
Curtice, A. Arthur, consulting, Rm. 1035, 215 W. Seventh St., Los Angeles, Calif..'24
Cushman, Joseph A., 76 Brook Rd., Sharon, Mass.....'24
Cutler, Willard W., Jr., consulting, 1002 Edison Bldg., Los Angeles, Calif.....'17
Cuyler, Robert H., Dept. of Geology, Univ. of Texas, Austin, Tex.....'29

Dahl, Arnold C., Shell Oil Co., Inc., Box 111, McLeansboro, Ill.....'34
Dahlgren, E. G., Interstate Oil Compact Commission, State Capitol Bldg., Oklahoma City, Okla.....'32
‖Dake, Helen Elizabeth, Plymouth Oil Co., Box 712, Sinton, Tex.....'40
Dake, Laurence F., Houston Oil Co. of Texas, Houston, Tex.....'40
Dallmus, Karl F., Standard Oil Co. of Venezuela, Apt. 1329, Caracas, Venezuela, S. A.....'28
Damesin, Leopold Constant Frederic, Compagnie Francaise des Petroles, 11 Ave. A. Briand, Vichy, France.....'37
Damon, H. Gordon, Box 1561, University Station, Austin, Tex.....'29
Damron, Wallace, Box 237, Damron Bldg., Owensboro, Ky.....'42
Dana, Drexler, Richfield Oil Corp., Bakersfield, Calif.....'27
Dana, E. B., c/o DeGolyer, MacNaughton & McGhee, Continental Bldg., Dallas, Tex.....'26
Dana, P. L., Gulf Refg. Co., Box 482, Mattoon, Ill.....'30

Dana, R. H., Stanolind Oil & Gas Co., Box 548, Brownfield, Tex.....'40
Dane, Carle H., U. S. Geol. Survey, Washington, D. C.....'35
Daniel, E. J., c/o Messrs. Grindlay & Co., Bankers, Bombay, India.....'38
‖Daniel, Guy S., Richmond Petr. Co. of Colombia, Apt. Nac. 2760, Bogota, Colombia, S. A.....'41
Daniel, Orion A., consulting, 700 City Natl. Bank Bldg., Wichita Falls, Tex.....'30
Daniels, James I., c/o Lockhart & Pryor, 820 Union Natl. Bank Bldg., Wichita, Kan.....'24
‖Danielson, G. Otis, Kerr-Lynn & Co., First Natl. Bank Bldg., Oklahoma City, Okla.....'40
Dannenberg, R. M., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'25
Dapples, Edward C., Dept. of Geology, Northwestern Univ., Evanston, Ill.....'41
Darke, Roy E., Standard Oil Co. of Calif., Bakersfield, Calif.....'27
*Darton, N. H., U. S. Geological Survey, Washington, D. C.....'38
Daubert, Charles A., 2102 W. King's Highway, San Antonio, Tex.....'25
‖Daugherty, C. G., Jr., Box 476, San Antonio, Tex. (Last address).....'39
David, Max, Box 792, Midland, Tex.....'41
Davidson, J. P., Bridwell Oil Co., Alice, Tex.....'33
Davies, Fred A., California Arabian Standard Oil Co., Rm. 700, 200 Bush St., San Francisco, Calif.....'20
Davies, Herman F., The California Co., 1816 Canal Bldg., New Orleans, La.....'27
Davies, Jack W., Halliburton Oil Well Cementing Co., 626 Waggoner Bldg., Wichita Falls, Tex.....'39
Davies, James Dudley, Shell Oil Co., Inc., Wichita Falls, Tex.....'39
‖Davies, Nathan C., 2232 E. Powell, Evansville, Ind.....'29
‖Daviess, Steven Norman, 2260 Beverly Glenn Pl., W. Los Angeles, Calif.....'41
‖Davis, Clyde E., Halliburton Oil Well Cementing Co., 1233 First Natl. Bank Bldg., Oklahoma City, Okla.....'39
Davis, Donald M., Pure Oil Co., Houston, Tex.....'26
Davis, Elmer Fred, Shell Oil Co., Inc., 614 Shell Bldg., 1008 W. Sixth St., Los Angeles, Calif.....'21
Davis, Flavy Eugene, Gulf Oil Corp., 1905 Gulf Bldg., Houston, Tex.....'39
‖Davis, Horace C., Puerto Cabezas, Nicaragua.....'39
Davis, Irion G., Mene Grande Oil Co., Apt. 709, Caracas, Venezuela, S. A.....'38
‖Davis, John Harvey, The Ohio Oil Co., Sheridan, Wyo.....'42
‖Davis, John R., Superior Oil Co., 807 Hamilton Bldg., Wichita Falls, Tex.....'39
Davis, Leon V., 806 Merrick St., Henryetta, Okla.....'38
Davis, Morgan J., Humble Oil & Refg. Co., Box 2180, Houston, Tex.....'26
Davis, Ralph E., c/o Ralph E. Davis, Inc., 1710 Union Bank Bldg., Pittsburgh, Pa..'19
Davis, Robert J., Shell Oil Co., Inc., 50 W. Fiftieth St., New York, N. Y.....'21
‖Davis, Roger H., Drilling & Expl. Co., Inc., Box 1575, Hobbs, N. Mex.....'40
‖Davis, Sidney H., Ozark Chemical Co., Tulsa, Okla.....'36
Davis, Thornton, Peerless Oil & Gas Co., Alamo Natl. Bldg., San Antonio, Tex.....'25
Davis, W. K., El Paso Nat. Gas Co., Box 981, Jal, N. Mex.....'41
Dawson, Edwin A., consulting, 1829 N. Broadway, Shawnee, Okla.....'30
Dawson, Herbert M., Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex.....'41
Dawson, Joseph M., consulting, 618 W. Summit St., San Antonio, Tex.....'23
‖Dawson, R. J., O. W. Dyer, Inc., 1606 Second Natl. Bank Bldg., Houston, Tex...'42
Day, Clarence O., Phillips Petr. Co., Box 1789, Shreveport, La.....'20
Day, James R., Amerada Petr. Corp., Box 591, Midland, Tex.....'30
Day, Willard L., Halliburton Oil Well Cementing Co., Corpus Christi, Tex.....'26
Dean, D. P., c/o Dean Bros., W. T. Waggoner Bldg., Fort Worth, Tex.....'19
Dean, P. C., c/o Dean Bros., W. T. Waggoner Bldg., Fort Worth, Tex.....'19
‖DeBlieux, Charles, Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'40
De Ceccatty, Pavans, Compagnie Generale de Geophysique, 30 Rue Fabert, Paris VII, France.....'39
Decius, L. Courtney, Associated Oil Co., Rm. 480, 79 New Montgomery St., San Francisco, Calif.....'19
*Decker, Charles E., Univ. of Oklahoma, Norman, Okla.....'17
Decker, LaVerne, consultant, Lamar Hotel, Houston, Tex.....'27
De Cousser, Kurt H., Socony-Vacuum Oil Co., Inc., White Star Div., Lansing, Mich.....'27
de Escallón, Marion Roberta, c/d Avianca, Barranquilla, Colombia, S. A.....'40
†DeFord, Ronald K., Box 865, Midland, Tex.....'25

‖DeGoes, Louis L., 4661 Pickford St., Los Angeles, Calif.....'41
DeGolyer, E., c/o DeGolyer, MacNaughton & McGhee, 1000 Continental Bldg., Dallas, Tex.....'17
de Juana, Clemente Gonzalez, Apt. 1253, Caracas, Venezuela, S. A.....'36
‖DeLançey, Charles J., 201-B Brackenridge Hall, Austin, Tex.....'41
de Laveaga, Miguel, Tide Water Associated Oil Co., Box H., Oildale, Calif.....'39
‖DeLong, James A., Amerada Petr. Corp., Box 896, Shawnee, Okla.....'38
DeMaris, Elmer L., General Petr. Corp., 1002 Higgins Bldg., Los Angeles, Calif..'37
Deming, J. H., The Texas, Co., Box 2332, Houston, Tex.....'38
Denison, A. R., Amerada Petr. Corp., Drawer 2040, Tulsa, Okla.....'21
Denman, C. E., Box 156, Great Bend, Kan.....'26
Dennis, Lyman Clark, Pure Oil Co., Box 1141, Jackson, Miss.....'41
‖Dennis, Terence Edwin, Superior Oil Co., Box 96, Bakersfield, Calif.....'41
‖Dennis, Wilbert C., 534 Wesson St., El Dorado, Ark.....'40
Denton, Frank R., consulting, 225 Owen Bldg., Tyler, Tex.....'38
Denton, Harold, Sun Oil Co., Box 2831, Beaumont, Tex.....'34
Deputy, P. R., consulting, 1035 N. Edgefield, Dallas, Tex.....'30
Derden, J. H., 1950 W. Magnolia, San Antonio, Tex.....'34
Desjardins, Louis H., Seismograph Service Co., Kennedy Bldg., Tulsa, Okla.....'40
‖Dessanti, R. N., 5080 Moron, Buenos Aires, Argentina, S. A.....'40
Detrick, Dana F., Wilshire Oil Co., 1710 Rotary Dr., Los Angeles, Calif.....'41
Deussen, Alexander, 1006 Shell Bldg., Houston, Tex.....'17
‖Deuth, Martin J., Shell Oil Co., Inc., Abilene, Tex.....'37
‖D'Evelyn, Morton, 3815½ W. Twenty-seventh St., Los Angeles, Calif.....'40
Devin, Fred A., Pure Oil Co., Box 2127, Amarillo, Tex.....'36
DeWolf, Frank W., Dept. of Geology, Univ. of Illinois, Urbana, Ill.....'20
‖Dexter, Laurence N., National Geophysical Co., Cuero, Tex.....'39
Dibblee, Thomas W., Jr., Richfield Oil Corp., Box 569, Ventura, Calif.....'37
Dicken, Russell, Box 65, Midland, Tex.....'28
Dickerson, Roy E., 39 Myrtle Ave. (Chatham Village), Upper Darby, Pa.....'25
Dickey, Parke A., senior geologist, State of Pennsylvania, Pleasantville, Pa.....'36
Dickey, Robert I., Forest Development Co., Box 1638, Midland, Tex.....'35
‖Dickinson, Bernard Neil, 310 E. Artesia Blvd., Bellflower, Calif.....'41
Dickinson, George, Venezuelan Oil Concessions, Ltd., Lagunillas, Estado Zulia, Venezuela, S. A.....'33
Dietert, Arthur E., Cities Service Oil Co., 705 Masonic Empire Bldg., Bartlesville, Okla.....'31
Dillard, W. Reese, Box 2204, Tulsa, Okla.....'35
Dille, Glenn Scott, 2202 E. Twenty-third St., Tulsa, Okla.....'28
Dinsmoor, C. G., 423rd Coast Art., Bn. (Comp.) (A.A.), Commanding Btry. D, A.P.O. 1004, c/o The Postmaster, New York, N. Y.....'32
Dismukes, J. S., Humble Oil & Refg. Co., Box 1331, Kingsville, Tex.....'39
Disney, Orville A., independent, General Delivery, Sedan, Kan.....'20
Dissinger, Earl, 1915 E. Alabama Ave., Houston, Tex.....'20
Ditsworth, Glenn William, The Texas Co., Salem, Ill.....'39
Dixon, A. Faison, c/o Brokaw, Dixon & McKee, 120 Broadway, New York, N. Y..'19
‖Doan, R. L., Phillips Petr. Co., Bartlesville, Okla.....'39
Dobbin, Carroll E., U. S. Geol. Survey, 224 Custom House, Denver, Colo.....'22
Dobie, Walter L., 211 N. Madison, El Dorado, Ark.....'26
Dobrick, Edward G., The California Co., 1818 Canal Bldg., New Orleans, La.....'41
‖Dockery, W. Lyle, Pure Oil Co., Box 1141, Jackson, Miss.....'41
Dodge, John F., Div. of Petroleum Eng., Univ. of California, Los Angeles, Calif..'24
‖Dodge, Theodore A., Box 49, Las Cruces, N. Mex.....'40
Dodson, Floyd C., Rm. 4, Holcomb-Blanton Bldg., San Angelo, Tex.....'23
Doeglas, Dirk J., Laboratory, Bataafsche Petr. Mij., Amsterdam (N), Netherlands.'36
Doell, Edward C., 42–3 "F" St., 11-C Camp, Taft, Calif.....'36
Doering, John, Southwood Oil Co., Inc., Continental Bldg., Dallas, Tex.....'30
‖Doherty, W. T., Fidelity Oil & Royalty Co., 2600 Esperson Bldg., Houston, Tex..'41
Dohm, C. F., Dominican Seaboard Oil Co., Apt. 111, Ciudad Trujillo, Dominican Republic.....'36
Donnell, James C., The Ohio Oil Co., Findlay, Ohio.....'38
Donnelly, Alden Stuart, Honolulu Oil Corp., Drawer 1391, Midland, Tex.....'30
Donnelly, Clarence W., The Ohio Oil Co., Box 186, Marshall, Ill.....'38
Donoghue, David, consulting, 1116 Fort Worth Natl. Bank Bldg., Fort Worth, Tex. '18

Donovan, Percy W., 1701 Foshay Tower, Minneapolis, Minn. . . . . '18
Dooley, A. B., Belridge Oil Co., McKittrick, Calif. . . . . '41
Dorn, Conrad L., Nederlandsche Pac. Petr. Mij., Medan, Sumatra, N.E.I. . . . . '38
Dorr, James B., Shell Oil Co., Inc., 641 M. & M. Bldg., Houston, Tex. . . . . '25
‖Dorr, John van Nostrand, 1511 Twenty-second St., N.W., Washington, D. C. (Last address) . . . . . '37
Dorrance, James R., The Texas Co., Rm. 8, Kern Co. Land Bldg., Bakersfield, Calif. . . . . '26
Dorsey, Geo. E., consulting, 1432 John St., Baltimore, Md. . . . . '24
‖Dorwart, George Martin, 334 S. Pasadena Ave., Pasadena, Calif. . . . . '42
Dott, Robert H., Oklahoma Geol. Survey, Norman, Okla. . . . . '18
Dougherty, Jack Francis, Geol. Dept., Phillips Petr. Co., Rule Bldg., Amarillo, Tex. . . . . '41
Dougherty, W. E., 402 N. Pecos, Midland, Tex. . . . . '38
Douglas, James M., consulting, Box 749, Paso Robles, Calif. . . . . '23
Douglas, John G., Mene Grande Oil Co., Apt. 234, Maracaibo, Venezuela, S. A. . . . . '27
Douglas, L. A., consulting, 1018 Milam Bldg., San Antonio, Tex. . . . . '30
Dovre, Adolph, 602 Milam Bldg., San Antonio, Tex. . . . . '22
Downing, R. B., Lane-Wells Co., Union Natl. Bank Bldg., Wichita, Kan. . . . . '30
Downs, George R., Carter Oil Co., Box 358, Bismarck, N. Dak. . . . . '36
Dozy, Jean Jacques, The Shell Co. of Ecuador, Apt. 340, Quito, Ecuador, S. A. . . . . '41
Drach, Gertrude M., Office of Petr. Coordinator for Natl. Defense, Prod. Div., Interior Bldg., Washington, D. C. . . . . '37
Drake, Cecil, Shell Oil Co., Inc., Box 476, Centralia, Ill. . . . . '29
‖Drake, Robert T., The Texas Co., Box 600, Wichita Falls, Tex. . . . . '41
Dreher, Otto, Carel van Bylandtlaan 30, The Hague, Netherlands. . . . . '21
Dresbach, C. H., Western Gulf Oil Co., 1260 Subway Terminal Bldg., Los Angeles, Calif. . . . . '31
Dresser, Myron A., Standard Oil Co. of N. J., Rm. 2130, 30 Rockefeller Plaza, New York, N. Y. . . . . '19
‖Drindak, Joseph Thomas, Union Prod. Co., Box 758, Laredo, Tex. . . . . '40
Driver, Herschel L., Standard Oil Co. of Calif., Los Angeles, Calif. . . . . '25
Duce, James Terry, California Arabian Standard Oil Co., 200 Bush St., San Francisco, Calif. . . . . '20
Ducloux, Abel Herrero, Dep. de Exploracion, Y.P.F., Avda. R. S. Pena 777, Buenos Aires, Argentina, S. A. . . . . '41
Dudley, Paul H., Richfield Oil Corp., Box 470, Long Beach, Calif. . . . . '38
Dumbros, Nicholas G., 3111 Twentieth St. N., Arlington, Va. . . . . '42
Dunbar, Clarence P., 1445 Perkins Rd., Baton Rouge, La. . . . . '36
‖Dunbar, Robert O., 406 First St. E., McCook, Neb. . . . . '42
‖Dunlap, George E., Sun Oil Co., Box 2880, Dallas, Tex. . . . . '40
‖Dunlap, John C., Geol. Dept., Union Sulphur Co., Inc., Sulphur, La. . . . . '40
Dunn, Burton C., The Ohio Oil Co., Box 86, Wichita, Kan. . . . . '36
Dunn, David A., consulting, Box 202, Tech. Station, Lubbock, Tex. . . . . '40
Durgan, Herbert L., Sun Oil Co., Seismograph Dept., Beaumont, Tex. . . . . '37
Durham, Charles A., International Petr. Co., Ltd., Guayaquil, Ecuador, S. A. . . . . '39
Durham, James H., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa. . . . . '37
Durham, John Wyatt, Dept. of Paleontology, Univ. of California, Berkeley, Calif. . . . . '39
Durkee, Robert R., 1951 Richmond Rd., Houston, Tex. . . . . '28
Durrell, Cordell, Dept. of Geology, Univ. of California, Los Angeles, Calif. . . . . '38
Durward, Robert H., consulting, 1431 W. Rosewood Ave., San Antonio, Tex. . . . . '26
Dykstra, Bouwe, Companie de Petroleo Shell de Colombia, Bogota, Colombia, S. A. '34

Eagles, Homer M., Standard Oil Co. of N. J., Tax Dept., 30 Rockefeller Plaza, New York, N. Y. . . . . '22
Earl, Eugene L., Fohs Oil Co., 923 Esperson Bldg., Houston, Tex. . . . . '33
Earl, Glenn M., 1043 Princeton St., Santa Monica, Calif. . . . . '37
Earl, Will F., The Ohio Oil Co., Box 266, Falls City, Neb. . . . . '25
‖Earle, Francis, Jr., Phillips Petr. Co., 1211 First Natl. Bank Bldg., Oklahoma City, Okla. . . . . '40
‖Easton, William Heyden, Illinois Geol. Survey, Urbana, Ill. . . . . '41
Eaton, J. Edmund, consulting, 2062 N. Sycamore Ave., Los Angeles, Calif. . . . . '25
Eaves, Everett, Magnolia Petr. Co., Box 1406, Shreveport, La. . . . . '35
Eberhardt, A. T., Shell Oil Co., Inc., Box 426, Evansville, Ind. . . . . '42

‖Eberle, Robert F., Tide Water Assoc. Oil Co., 418 Court Bldg., Evansville, Ind...'40
Eby, J. Brian, consulting, Box 962, Houston, Tex.....'25
‖Echols, Dorothy Jung, The Texas Co., 135 E. Forty-second St., New York, N. Y..'41
‖Eckart, Robert R., Jr., Shell Oil Co., Inc., Kilgore, Tex.....'41
Eckenwiler, Cleo W., Carter Oil Co., Box 801, Tulsa, Okla.....'32
Eckert, Frank E., manager, Hanley & Bird, Bradford, Pa.....'21
Eckhardt, E. A., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa.....'30
Eckis, Rollin, Richfield Oil Corp., 560 Haberfelde Bldg., Bakersfield, Calif.....'36
Edmiston, E. K., 705 Fourth Natl. Bank Bldg., Wichita, Kan.....'38
Edson, Dwight J., Edson Petr. Co., 1507 Esperson Bldg., Houston, Tex.....'22
Edson, Fanny C., 1835 N. Locust St., Denton, Tex.....'22
Edstrom, Donald E., Sinclair Prairie Oil Co., Anadarko, Okla.....'40
Edwards, Allan K. M., Australasian Petr. Co., Port Moresby, Papua.....'38
Edwards, Everett C., General Petr. Corp., 1003 Higgins Bldg., Los Angeles, Calif...'23
‖Edwards, Hall, Superior Oil Co., Evansville, Ind.....'28
Edwards, Merwin G., Shell Oil Co., Inc., 1008 W. Sixth St., Los Angeles, Calif....'25
Effinger, William L., 52 Kebon Sirih, Batavia-Centrum, Java, N.E.I.....'38
Egan, J. A., consulting, 920 Palace Bldg., Tulsa, Okla.....'23
Egan, Martin G., 2504 Casey Ave., Mt. Vernon, Ill.....'36
‖Ehlers, Allen, Carter Oil Co., Harrisburg, Ill.....'38
‖Eicher, Donald B., Standard Oil Co. of Egypt, S. A., 22 Sharia Kasr el Nil, Cairo, Egypt.....'41
Eifler, Gus Kearney, Jr., 2809 N. Guadalupe, Austin, Tex.....'40
Eirich, Constance G., Gulf Oil Corp., Box 661, Tulsa, Okla.....'21
‖Ekholm, Victor E., independent, Box 2400, Dallas, Tex.....'28
Elder, Stanley G., Sun Oil Co., Old Natl. Bank Bldg., Evansville, Ind.....'36
Eley, Hugh M., Magnolia Petr. Co., Box. 633, Midland, Tex.....'40
‖Elkins, Campbell H., Lubbock Natl. Bank, Lubbock, Tex.....'40
Elledge, E. R., Phillips Petr. Co., 610 Ellis-Singleton Bldg., Wichita, Kan.....'25
Elliott, A. C., Box 403, Pilot Point, Tex.....'35
Elliott, George R., Prod. Div., Phillips Petr. Co., Bartlesville, Okla.....'26
Elliott, J. E., 3404 Yoakam Blvd., Houston, Tex.....'19
Ellis, Albert D., Jr., Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'36
Ellis, George L., 436 S. Forty-ninth St., Philadelphia, Pa.....'24
‖Ellis, John Reese, c/o J. R. Ellis, Helena Agency, R.F.C., Helena, Mont.....'42
Ellison, Burton Rolland, Standard Oil Co. of Calif., Bin XX, Taft, Calif.....'38
Ellison, Charles W., consulting, 801½ E. Moses, Cushing Okla.....'30
Ellison, Kenneth A., consulting, 736 E. Eighteenth St., Oklahoma City, Okla.....'28
Ellison, Samuel P., Jr., Missouri School of Mines, Rolla, Mo.....'38
Ellisor, Alva C., Humble Oil & Refg. Co., 1062 Humble Bldg., Houston, Tex.....'21
Ellsworth, Elmer W., consulting, Wham Bldg., 212 E. Broadway, Centralia, Ill....'36
Elms, Morris A., Phillips Petr. Co., 338 Milam Bldg., San Antonio, Tex.....'38
Elson, William H., 522 Beacon Bldg., Tulsa, Okla.....'27
Ely, Fred B., c/o Rockwood Associates, Inc., 63 Wall St., New York, N. Y.....'20
Ely, George N., Continental Oil Co., Midland, Tex.....'40
Emch, John W., independent, San Angelo Natl. Bank Bldg., San Angelo, Tex.....'25
Emery, Wilson B., The Ohio Oil Co., Findlay, Ohio.....'23
Emmerich, Harry H., Magnolia Petr. Co., Box 239, Wichita Falls, Tex.....'39
Emmons, William H., Univ. of Minnesota, Minneapolis, Minn.....'19
Emrick, D. G., Gulf Oil Corp., Box 661, Tulsa, Okla.....'28
Enders, Dean W., Warren, Mont.....'41
Engel, Noel W., Superior Oil Co., Evansville, Ind.....'38
Engleman, Rolf, Box 1151, Seminole, Okla.....'25
English, Leon E., Burch Hotel, Breckenridge, Tex.....'18
English, R. M., Carter Oil Co., Box 296, Harrisburg, Ill.....'36
English, Walter A., Continental Air Map Co., 114 S. Beaudry Ave., Los Angeles, Calif.'19
Engstrand, Clinton, Shell Oil Co., Inc., Wichita Falls, Tex.....'35
Erdmann, Charles E., U. S. Geol. Survey, 224 Custom House, Denver, Colo.....'30
Erni, Arthur, Bachofenstrasse 27, Basle, Switzerland.....'21
‖Ervin, Lynn D., Box 70, R. 2, Glenwood Springs, Colo.....'40
Esarey, Ralph E., 924 E. Atwater Blvd., Bloomington, Ind.....'32
Esgen, W. K., c/o Trinity Petr. Co., 1706 Esperson Bldg., Houston, Tex.....'29
Eskrigge, Tatham R., Gulf Refg. Co., Box 67, Buras, La.....'30

Espach, Ralph H., U. S. Bur. of Mines, Box 877, Laramie, Wyo. '37
Estabrook, Edward L., Standard Oil Co. of N. J., Rm. 2743, 30 Rockefeller Plaza, New York, N. Y. '20
‖Esunas, Bernard Joseph, Turner Field, Albany, Ga. '40
Etherington, Thomas J., Richmond Petr. Co. of Colombia, Apt. Nac. 2760, Bogota, Colombia, S. A. '33
Evanoff, John, Valle de la Pascua, Estado Guarico, Venezuela, S. A. '38
Evans, David Morgan, Honolulu Oil Corp., 2213 Twenty-fourth St., Lubbock, Tex. '37
Evans, Frank G., Shell Oil Co., Inc., Box 2099, Houston, Tex. '28
‖Evans, Louis H., 12273 San Vicente Blvd., Los Angeles, Calif. '24
Evans, Noel, Tide Water Assoc. Oil Co., Box 1404, Houston, Tex. '20
Evans, Vincent, Carter Oil Co., Box 128, Lexington, Miss. '31
‖Everett, Rizer, General Delivery, Okolona, Miss. '38
‖Ewing, Rudolph V., Geol. Dept., Continental Oil Co., Ponca City, Okla. '41
Eyssell, Alfred R., Peerless Oil & Gas Co., Alamo Natl. Bldg., San Antonio, Tex. '25

Fabiani, Ramiro, Instituto Geologo-R. Universita, via Maqueda, Palermo 7, Italy '35
‖Fackler, John H., 3954 Ibis St., San Diego, Calif. '39
Fagginer-Auer, Willem A., Apt. 376, Managua, Nicaragua '41
Fahle, Paul B., Pilgrim Expl. Co., 1405 Second Natl. Bank Bldg., Houston, Tex. '38
‖Falconer, W. L., Abasand Oils, Ltd., Edmonton, Alta., Canada '41
‖Falletti, A. D., c/o W. C. McBride, Inc., Box 209, Evansville, Ind. '38
‖Fanguy, Nolan A., 639 E. Park Ave., Houma, La. '40
Fanshawe, John R., Box 122, Rensselaer, Ind. '40
Farish, Linn M., Apt. 126, 3546 Seventy-fourth St., Jackson Heights, Long Island, N. Y. '28
Farlee, Richard Wilson, Shell Oil Co., Inc., Box 476, Centralia, Ill. '41
‖Farley, William Richard, Expl. Dept., Union Sulphur Co., Sulphur, La. '39
‖Farmer, Edward Clifton, Amerada Petr. Corp., 417 S. Hill St., Los Angeles, Calif. '40
Farmer, Russell, Stanolind Oil & Gas Co., Box 1540, Midland, Tex. '40
‖Farrand, William Gardner, Sun Oil Co., Old Natl. Bank Bldg., Evansville, Ind. '40
Farrell, Agnes M., U. S. Geol. Survey, 706 Harvard Hall, 1650 Harvard St. N.W., Washington, D. C. '26
Fash, Ralph H., consulting chemist, Box 1379, Fort Worth, Tex. '27
Fath, A. E., Socony-Vacuum Oil Co., Inc., 26 Broadway, New York, N. Y. '17
‖Faust, Josef, consulting, 618 Commerce Exchange Bldg., Oklahoma City, Okla. '31
Feagin, Barney, Jr., producer, 330 Ritz Bldg., Tulsa, Okla. '30
Feather, Virgil G., Phillips Petr. Co., Box 49, Holdenville, Okla. '38
‖Feldmeyer, Arthur E., Superior Oil Co. of New Zealand, Ltd., National Bank Chambers, Palmerston N., N. Z. '39
‖Fell, Harold B., Simpson-Fell Oil Co., Box 778, Ardmore, Okla. '36
Fellows, Robert A., Pure Oil Co., Box 311, Olney, Ill. '41
Fenn, Ivan J., Subterrex, 701 Waugh Dr., Houston, Tex. '29
‖Feray, Dan Edwards, Dept. of Geology, Univ. of Wisconsin, Madison, Wis. '40
‖Ferber, Herbert J., Western Gulf Oil Co., Box 627, Fresno, Calif. '39
‖Ferebee, D. M., 317 S. Seventh St., Mt. Vernon, Ill. '39
Fergus, Preston, Union Prod. Co., Box 1422, Monroe, La. '27
Ferguson, Carlos M., Box 47, Brownfield, Tex. '39
Ferguson, Glenn C., Union Oil Co. of Calif., Kern Co. Land Bldg., Bakersfield, Calif. '30
‖Ferguson, Herman W., G-5, State Office Bldg., Nashville, Tenn. '41
Ferguson, Hershal C., 1208 Esperson Bldg., Houston, Tex. '38
‖Ferguson, John I., F.A., 826th T.D. Bn. (H), East Garrison, Camp Roberts, Calif. '41
Ferguson, John L., Amerada Petr. Corp., Drawer 2040, Tulsa, Okla. '20
Ferguson, Kenneth S., Shell Oil Co., Inc., Box 1509, Midland, Tex. '27
Ferguson, M. L., 3149 Lawnview, Corpus Christi, Tex. '39
Ferguson, R. N., consulting, 1332 A. G. Bartlett Bldg., Los Angeles, Calif. '19
Ferguson, W. B., Box 729, Brenham, Tex. '29
Ferrando, A., Standard Oil Co. of Texas, Box 1249, Houston, Tex. '38
‖Ferrell, Jane, Skelly Oil Co., Midland, Tex. '41
‖Ferrell, Max E., Mountain View, Mo. '41
Ferrero, Clarence, c/o Dr. F. F. Courts, Box 3, New Iberia, La. '28
Feruglio, Egidio, Instituto de Petroleo, Universidad Nacional, San Martin 957, Mendoza, Argentina, S. A. '38

Fettke, Charles R., Carnegie Inst. of Technology, Pittsburgh, Pa.....'20
Fichter, H. J., Cia Petroleo Shell, Apt. 114, Bogota, Colombia, S. A.....'41
Fidlar, M. M., 523 S. Park Ave., Bloomington, Ind.....'39
Fields, Harry B., Ultramar S.A.P.A., 20 de Febrero 188, Salta, Argentina, S. A.....'28
Finch, Elmer H., 143 E. Mistletoe, San Antonio, Tex.....'22
Finch, John Wellington, Rm. 1712, 25 Broadway, New York, N. Y.....'24
‖Finfrock, Lawrence J., 407 W. Elm St., Urbana, Ill.....'41
Finley, J. C., Midstates Oil Co., 518 Natl. Bank of Tulsa, Tulsa, Okla.....'34
Finn, Fenton H., Peoples Nat. Gas Co., 545 William Penn Way, Pittsburgh, Pa...'41
Fipps, E. L., 205 S. Sixth St., Mt. Vernon, Ill.....'26
Fischer, O., Gas Dept., Owens, Libbey-Owens, Box 1375, Charleston, W. Va.....'17
Fischer, Victor N., Shell Oil Co., Inc., Box 1347, Shreveport, La.....'38
Fish, Leroy, The Texas Co., Box 524, Corsicana, Tex.....'41
Fisher, Barney, Coronado Corp., 406 Continental Bldg., Dallas, Tex.....'36
Fisher, Dunbar A., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex.....'36
‖Fisher, Frank L., Atlantic Refg. Co., Beacon Bldg., Wichita, Kan.....'38
‖Fisher, Gordon H., Gulf Oil Corp., Box 1290, Fort Worth, Tex.....'42
Fisher, Theodore Glen, Cities Service Oil Co., Box 2832, Odessa, Tex.....'42
Fisk, Harold N., Louisiana State Univ., Geology Dept., Baton Rouge, La.....'38
‖Fitts, L. E., Jr., Sinclair Prairie Oil Co., Box 521, Tulsa, Okla.....'42
FitzGerald, James, Jr., Skelly Oil Co., Box 993, Midland, Tex.....'25
Fitzgerald, Paul E., Dowell, Inc., 529 Kennedy Bldg., Tulsa, Okla.....'30
Fitzgerald, Thomas J., Richfield Oil Corp., 560 Haberfelde Bldg., Bakersfield, Calif.....'29
Flagler, C. W., Gulf Oil Corp., Rm. 1615, 17 Battery Pl., New York, N. Y.....'30
Flesh, David J., 905 City Bank Bldg., Shreveport, La.....'38
Fletcher, Claude Osborne, Union Prod. Co., Box 711, Corpus Christi, Tex.....'36
Flowers, Jack, Humble Oil & Refg. Co., 256 Humble Bldg., Houston, Tex.....'38
Floyd, Florin W., Standard Oil Co. of Venezuela, Apt. 889, Caracas, Venezuela, S. A.'23
Flude, John W., 5219 Dunlavy St., Houston, Tex.....'37
Fly, Paul J., Mar-Tex Oil Co., 2405 Esperson Bldg., Houston, Tex.....'31
Fohs, F. Julius, c/o Fohs Oil Co., Esperson Bldg., Houston, Tex.....'17
Foley, Edward J., Standard Oil Co. of Egypt, Sharia Kasr el Nil 22, Cairo, Egypt..'38
Foley, Lyndon L., 514 McBirney Bldg., Tulsa, Okla.....'22
Folger, Anthony, Gulf Oil Corp., 1107 Union Natl. Bank Bldg., Wichita, Kan.....'22
‖Folk, Stewart, Magnolia Petr. Co., Box 163, Mt. Vernon, Ill.....'40
‖Folsom, L. W., W. Virginia Geol. Survey, Morgantown, W. Va.....'40
Fonville, Herman A., 1515 Ninth St., Wichita Falls, Tex.....'27
Foran, William T., c/o D. C. Harrell, Drawer 1490, Jackson, Miss.....'31
Ford, Carl S., independent, Bass Bldg., Enid, Okla.....'18
Ford, W. E., Jr., Royalty Service Corp., Ltd., 555 S. Flower St., Los Angeles, Calif..'38
Forgeron, Harold S., consulting, Box 1575, Midland, Tex.....'28
‖Forney, Maurice E., Atlantic Refg. Co., Tulsa, Okla.....'41
‖Forrest, Lesh C., 446 N. Gregory St., Whittier, Calif.....'38
Forsyth, Roderick, Case, Pomeroy & Co., Inc., Koenig Bldg., 112 N.W. Fourth St., Evansville, Ind.....'38
Fortier, Leo R., 248 N. Pinecrest, Wichita, Kan.....'25
Fortine, Dwight H., Barnsdall Oil Co., Petroleum Bldg., Los Angeles, Calif.....'30
Fosdick, Arthur R., c/o Luse & Fosdick Drilling Co., Dallas, Tex.....'32
Fossa-Mancini, Enrico, Museo de la Plata, La Plata, Argentina, S. A.....'31
‖Fosshage, E. W., Shell Oil Co., Inc., Tulsa, Okla.....'37
Foster, Alden W., 2247 Oliver Bldg., Pittsburgh, Pa.....'20
‖Fountain, H. C., Box 539, Laredo, Tex.....'40
Fournier, F. L., International Petr. Co., Ltd., Guayaquil, Ecuador, S. A.....'41
‖Fouts, J. M., Prod. Dept., Shell Oil Co., Inc., Box 591, Morgan City, La.....'38
Fowler, Charles W., Jr., Pantepec Oil Co., Apt. 43, Barcelona, Venezuela, S. A.....'26
Fowler, George M., consulting, 608 Joplin Natl. Bank Bldg., Joplin, Mo.....'23
Fox, James P., Nederlandsche Pac. Petr. Mij., Paleisweg 33, Medan, Sumatra, N.E.I.....'29
Fox, Steven K., Dept. of Geology, Princeton Univ., Princeton, N. J.....'40
Fralich, Charles E., Belmont Quadrangle Drilling Co., Box 373, Bradford, Pa.....'25
Franklin, Louis, c/o Franklin & Tidemann, Ltd., 1403 Mellie Esperson Bldg., Houston, Tex.....'20

Franks, Robert M., Box 970, Alice, Tex. '30
Frazell, W. D., Union Prod. Co., Shreveport, La. '38
‖Frederickson, Edward A., Dept. of Geology, Univ. of Oklahoma, Norman, Okla. '41
Freed, Richard, The Texas Co., Box 1737, Shreveport, La. '40
Freedman, L. H., 116 Hazelwood Dr., Fort Worth, Tex. '22
Freeman, Louise Barton, Dept. of Mines & Minerals, Lexington, Ky. '41
Freie, A. J., Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A. '28
Frey, Alfred P., Shell Oil Co., Inc., Centralia, Ill. '24
‖Frink, John W., Hales Bar Dam, Guild, Tenn. '38
Frischknecht, Gustav, Stapferstrasse 39, Zurich 6, Switzerland '35
Fritts, Harold M., Expl. Dept., Shell Oil Co., Inc., Houston, Tex. '26
Fritz, William Clayton, consulting, 1910 W. College St., Midland, Tex. '35
Frizzell, Don L., International Petr. Co., Ltd., Negritos, Peru, S. A. '40
Frizzell, Mildred Armor, 1201 N. Pennsylvania, Oklahoma City, Okla. '30
Frost, Jack, 1110 Tower Petroleum Bldg., Dallas, Tex. '22
‖Frost, Jay Miles, III, 803 Mellie Esperson Bldg., Houston, Tex. '38
‖Fry, Earl E., Cities Service Oil Co., Box 532, Lafayette, Ind. '40
‖Fryou, Joe A., Box 1268, Bay City, Tex. '40
Fuellhart, Donald E., Brokaw, Dixon & McKee, 120 Broadway, New York, N. Y. '29
‖Fugate, Ross James, Box 365, Roscommon, Mich. '40
Fuller, Melville Weston, Carter Oil Co., Box 568, Mattoon, Ill. '36
‖Fullerton, Donald A., c/o Mrs. O. N. Fullerton, 2430 Jackson St., San Francisco, Calif. (Last address) '39
Fulton, Loris J., Pure Oil Co., Box 443, Bismarck, N. Dak. '29
Funk, Fred J., The Ohio Oil Co., Findlay, Ohio '28
Funk, Marion H., Sun Oil Co., Box 424, Midland, Tex. '24
Funkhouser, E. M., Woodley Petr. Co., Box 1403, Houston, Tex. '36
‖Funkhouser, H. J., Mene Grande Oil Co., Apt. 45, Barcelona, Venezuela, S. A. '39
Fuqua, H. B., Gulf Oil Corp., Box 1290, Fort Worth, Tex. '20
‖Fuqua, Marjorie, Humble Oil & Refg. Co., Houston, Tex. '40
Fyfe, Douglas, Arenales 1423, Lima, Peru, S. A. '20

Gaby, Edwin D., Geophysical Service, Inc., 1311 Republic Bank Bldg., Dallas, Tex. '40
Gaddess, Jack, N. Pennsylvania Gas Co., Port Allegany, Pa. '25
‖Gaenslen, George, Box 2111, Corpus Christi, Tex. '38
‖Gaffney, John E., Lion Oil Refg. Co., El Dorado, Ark. '41
‖Gagnebin, Elie A., Laboratoire de Geologie, Universite, Lusanne, Switzerland '40
Gahagan, Donald I., Skelly Oil Co., 1353 Esperson Bldg., Houston, Tex. '39
Gahring, William R., Ross Oil Co., Box 520, Shawnee, Okla. '25
Galbraith, T. J., The California Co., Box 1249, Houston, Tex. '20
Galbreath, Glenn, independent, 418 W. Broadway, Centralia, Ill. '40
‖Gale, Arthur S., Jr., The Texas Co., Box 2332, Houston, Tex. '39
Gale, Hoyt Rodney, Pasadena Junior College, Pasadena, Calif. '29
Galey, John Taylor, independent, 2615 Grant Bldg., Pittsburgh, Pa. '35
Galley, John E., Shell Oil Co., Inc., 1009 Central Bldg., Wichita, Kan. '29
‖Gallie, John F., Box 2585, Houston, Tex. '41
Galliher, E. Wayne, Barnsdall Oil Co., Petroleum Securities Bldg., Los Angeles, Calif. '36
Galloway, Alan J., Shell Oil Co., Inc., Box 2099, Houston, Tex. '39
‖Galloway, George Harold, Stanolind Oil & Gas Co., 429 First Natl. Bldg., Wichita, Kan. '41
Galloway, J. J., Dept. of Geology, Univ. of Indiana, Bloomington, Ind. '25
Galloway, John O., 700 Lancaster Bldg., Calgary, Alta., Canada '21
Galpin, Sidney L., 44 Jones Ave., Morgantown, W. Va. '19
‖Garber, Marshall West, Box 650, Diablo Heights, Panama Canal Zone '39
‖Gardett, Peter H., General Petr. Co., 1002 Higgins Bldg., Los Angeles, Calif. '40
Gardiner, Chester M., Rm. 1024, 530 W. Sixth St., Los Angeles, Calif. '25
‖Gardner, A. Maclay, 1903 Orchid Ave., Hollywood, Calif. '30
‖Gardner, Edgar J., 2328 Swift, Houston, Tex. '39
‖Gardner, Frank J., 1808 Congress St., Austin, Tex. '40
Gardner, James H., c/o Gardner Petr. Co., 326 Beacon Bldg., Tulsa, Okla. '17
Gardner, Julia, U. S. Geol. Survey, Washington, D. C. '27
Garfias, Valentine R., Madera 35, Mexico City, Mex. '19

Gariepy, Glen Bernard, The Ohio Oil Co., 904 Ohio Oil Bldg., Los Angeles, Calif...'39
Garlough, J. L., consulting, 413 Fourth Natl. Bank Bldg., Wichita, Kan.....'28
Garner, Aubrey H., consulting, Continental Bldg., Dallas, Tex.....'19
Garnjost, Frederick W., Spuyten Duyvil, New York, N. Y.....'21
Garrett, J. B., Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'35
Garrett, Lovic P., Gulf Oil Corp., Houston, Tex.....'18
Garrett, Melvin M., consulting, 1914 Republic Bank Bldg., Dallas, Tex.....'21
Garrett, Robert E., consulting, 301 Beacon Bldg., Tulsa, Okla.....'21
Garst, Jarvis, Plymouth Oil Co., Sinton, Tex.....'31
Gartner, James L., Well Surveys, Inc., 412 S. Kenosha, Tulsa, Okla.....'19
‖Garwood, Roland, Texas Petr. Co., Apt. Nac. 877, Bogota, Colombia, S. A.....'40
Gawthrop, R. M., Sinclair Prairie Oil Co., Box 521, Tulsa, Okla.....'23
Gay, Andrew H., Box 783, Baton Rouge, La.....'39
Gaylord, E. G., Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif.....'20
Gealy, Wendell B., Gulf Oil Corp., Box 1166, Pittsburgh, Pa.....'26
Geis, Wilfrid H., Union Oil Co. of Calif., Los Angeles, Calif.....'23
Gemmell, Howard F., Gulf Research & Dev. Co., Drawer 2038, Pittsburgh, Pa...'38
Gentry, Albert William, Shell Oil Co., Inc., Los Angeles, Calif.....'39
Gentry, H. L., 921 E. Michigan Ave., Jackson, Miss.....'38
George, Robert Freeman, consulting, 705 Union Natl. Bank Bldg., Wichita, Kan...'37
George, W. O., U. S. Geol. Survey, Austin, Tex.....'24
Georgesen, Niels C., 1302 N. Mulberry St., Mt. Carmel, Ill.....'39
Gerdes, C. H., Socony-Vacuum Oil Co. C.A., Apt. 246, Caracas, Venezuela, S. A...'39
Germany, E. B., 86½ Highland Park Village, Dallas, Tex.....'26
‖Germond, Kenneth W., Shasta Oil Co., Box 711, Midland, Tex.....'42
Gester, George C., Standard Oil Co. of Calif., 1129 Standard Oil Bldg., San Francisco, Calif.....'20
Gester, Stephen H., Standard Oil Co. of Calif., 1128 Standard Oil Bldg., San Francisco, Calif.....'21
Getzendaner, A. E., 3001 Plumb Street, Houston, Tex.....'24
Getzendaner, Frank M., Humble Oil & Refg. Co., Uvalde, Tex.....'21
Gevaerts, E. A. L., Burma Oil Co., Box 1049, Rangoon, Burma.....'28
‖Geyer, Robert L., Shell Oil Co., Inc., Box 1162, Vernon, Tex.....'39
‖Gibbs, Harley S., consulting, 314 Columbia Bldg., Pittsburgh, Pa.....'30
Gibbs, James F., Panhandle Refg. Co., Wichita Falls, Tex.....'27
‖Gibson, Donald Thomas, 2008 Twenty-sixth St., Lubbock, Tex.....'38
Gibson, George Drew, Petty Geophysical Eng. Co., Box 835, Norman, Okla.....'37
Giddings, H., The Texas Co., Box 1720, Fort Worth, Tex.....'26
Gierhart, Guy B., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex.....'28
Giesey, S. C., Union Oil Co. of Calif., Midland, Tex.....'36
Giffin, Wilson C., 2320 Pasadena Ave., Long Beach, Calif.....'19
Gilbert, A. C., Devonian Oil Co., 1129 Milam Bldg., San Antonio, Tex.....'28
Gile, Richard E., British-American Oil Prod. Co., Box 1047, Oklahoma City, Okla...'29
Giles, Albert W., Dept. of Geology, Univ. of Arkansas, Fayetteville, Ark.....'22
Giles, John M., 5367 Wingohocking Terrace, Germantown, Pa.....'26
Gill, J. P., Sinclair Prairie Oil Co., Ardmore, Okla.....'38
Gill, J. Willard, Pure Oil Co., 407 Slattery Bldg., Shreveport, La.....'35
Gillan, Silas L., consulting, 230 Webb Dr., Glendale, Calif.....'26
Gillette, Tracy, Illinois Geol. Survey Division, Urbana, Ill.....'37
Gillson, Joseph L., E. I. du Pont de Nemours & Co., Rm. 8063, du Pont Bldg., Wilmington, Del.....'30
Gilluly, James, Univ. of California, W. Los Angeles, Calif.....'39
‖Gilmore, Kathleen K., 2825 Fondren Dr., Dallas, Tex.....'38
Gilmour, Andrew, Amerada Petr. Corp., Drawer 2040, Tulsa, Okla.....'29
Giltinan, George Murray, Seismograph Service Corp., Tulsa, Okla.....'39
‖Gimbrede, Louis DeA., 3214 Randall, Garden Oaks, Houston, Tex.....'39
Ginter, Roy L., Ginter Chemical Laboratory, 118 W. Cameron, Tulsa, Okla.....'33
Girdler, J. H., Atlantic Steel Co., Box 1714, Atlanta, Ga.....'39
Girdler, Tom M., Jr., The Texas Co., Box 1270, Midland, Tex.....'38
‖Gisburne, John Robert, 1030 Stanley Dr., Wichita, Kan.....'41
Gish, Wesley G., Transwestern Oil Co., 1600 Milam Bldg., San Antonio, Tex.....'22
Glass, Theodore G., Sinclair Wyoming Oil Co., Bairoil, Wyo.....'38
‖Gleddie, Joseph, Tilley Station, Alta., Canada.....'40

Glenn, L. C., Vanderbilt University, Nashville, Tenn.....'19
Glover, Sheldon L., 517 O'Farrell St., Olympia, Wash.....'38
‖Godde, H. A., Signal Oil & Gas Co., 811 W. Seventh St., Los Angeles, Calif.....'25
‖Goebel, Lawrence A., Carter Oil Co., Box 548, Ferriday, La.....'39
Goerner, Fred S., The California Co., 1818 Canal Bldg., New Orleans, La.....'38
Golden, John M., Elflex Co., 1706 Niels Esperson Bldg., Houston, Tex.....'38
Goldschmid, Karl Theodor, Shell Co. of Ecuador, Apt. 340, Quito, Ecuador, S. A...'41
‖Goldsmith, L. Jean, 644 Landfair Ave., #206, Los Angeles, Calif.....'41
‖Goldstein, August, Jr., 935 Thora Blvd., Shreveport, La.....'41
Goldston, Walter L., Jr., Oil & Gas Bldg., Houston, Tex.....'20
Goldstone, Frank, Shell Oil Co., Inc., Box 2099, Houston, Tex.....'30
Goodman, John V., 435 Sixth Ave., Pittsburgh, Pa.....'38
Goodman, P. W., consulting, Box 884, Shawnee, Okla.....'31
*Goodrich, Harold B., 1628 S. Cincinnati, Tulsa, Okla.....'18
Goodrich, Paul K., 3rd Army Headquarters, Presidio of Monterey, Calif.....'30
Goodrich, Raymond H., 2901 Gulf Bldg., Houston, Tex.....'24
Goodrich, Robert D., 706 Fort Worth Natl. Bank Bldg., Fort Worth, Tex.....'18
Goodwill, Donald, Jr., Balter Bldg., New Orleans, La.....'31
Gordon, Dugald, Gulf Bldg., Houston, Tex.....'22
Gorman, William A., Pan-American Prod. Co., 1245 Mellie Esperson Bldg., Houston, Tex.....'38
Goudkoff, Paul P., consulting, 799 Subway Terminal Bldg., Los Angeles, Calif...'25
‖Goudy, Louis W., Stanolind Oil & Gas Co., Box 1099, Shawnee, Okla.....'41*
Gouin, Frank, Box 208, Duncan, Okla.....'19
Gould, Charles N., Box 88, Norman, Okla.....'17
Gow, Kenneth L., Superior Oil Co., 1004 Citizens Natl. Bank Bldg., Evansville, Ind.'31
Graeber, Clyde P., Investors Royalty Co., Inc., 1008 Thompson Bldg., Tulsa, Okla..'37
Grage, Victor P., 1102 City Bank Bldg., Shreveport, La.....'30
Graham, B. L., 1111 Johnstone Ave., Bartlesville, Okla.....'29
‖Graham, David H., c/o Mrs. L. F. Graham, 1615½ S. New Hampshire, Los Angeles, Calif.....'37
‖Graham, Gordon L., c/o DeGolyer, MacNaughton & McGee, Continental Bldg., Dallas, Tex.....'41
‖Gram, Oscar Ebsen, The Ohio Oil Co., Marshall, Ill.....'41
‖Granberry, Raymond J., Rt. 2, Box 212, De Ridder, La.....'40
Grant, Paul A., Columbus, Mont.....'23
Grant, Rex P., Dept. of Conservation, State of Michigan, Lansing, Mich.....'40
Grant, U. S., IV, Dept. of Geology, Univ. of California, Los Angeles, Calif.....'32
Gravell, Donald W., Atlantic Refg. Co. of Cuba, 401 Edificio la Metropolitana, Havana, Cuba.....'38
‖Graves, Allan Dexter, Socony-Vacuum Oil Co. de Colombia, Apt. Nac. 1140, Bogota, Colombia, S. A.....'39
Gray, Alfred, Atlantic Refg. Co., Magnolia Bldg., Dallas, Tex.....'20
‖Gray, Donald A., Stanolind Oil & Gas Co., Fair Bldg., Fort Worth, Tex.....'40
‖Gray, John Gardiner, Standard Oil Co. of British Columbia, Ltd., 906 Marine Bldg., Vancouver, B. C., Canada.....'40
Gray, K. Washington, Australasian Petr. Co. Pty., Ltd., Port Moresby, Papua....'37
Gray, Shapleigh G., Tide Water Assoc. Oil Co., Box 1404, Houston, Tex.....'28
Gray, William D., c/o Gray & Wolfe, 815 Second Natl. Bank Bldg., Houston, Tex..'27
Green, Cecil H., Geophysical Service, Inc., 1311 Republic Bank Bldg., Dallas, Tex..'36
‖Green, Charles C., Jr., Shell Oil Co., Inc., Box 1509, Midland, Tex.....'40
Green, Darsie A., The Pure Oil Co., Box 311, Olney, Ill.....'25
Green, George Gardiner, independent, 813 Ardis Bldg., Shreveport, La.....'39
Green, Guy E., Wellington Oil Co., 1108 S. Texas Bank Bldg., San Antonio, Tex...'24
‖Green, Thomas Henning, Shell Oil Co., Inc., Tulsa, Okla.....'41
Green, William G., Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla..'33
Greene, Frank C., Missouri Geol. Survey, Box 138, Rolla, Mo.....'17
Greene, R. G., Union Pacific Rwy., Expl. Dept., 422 W. Sixth St., Los Angeles, Calif.....'20
Greenham, Roy L. Australasian Petr. Co. Pty., Ltd., Port Moresby, Papua.....'42
Gregersen, Albert, The Texas Co., 929 S. Broadway, Los Angeles, Calif.....'35
Gregory, J. N., consulting, Box 243, San Angelo, Tex.....'30
Gregory, Peter Paul, Yates Pool Eng. Committee, Box 578, Iraan, Tex.....'39

Greig, Douglas A., c/o Thos. Cook & Son (Bankers), Ltd., Head Office, Berkeley St., Piccadilly, London, W. 1, England....'30
‖Gribbin, D. J., Jr., General Petr. Corp. of Calif., 1003 Higgins Bldg., 108 W. Second St., Los Angeles, Calif....'37
‖Griffin, Irving M., Jr., General Geophysical Co., Houston, Tex....'38
Griffith, Glenn R. V., 2447 E. Twentieth St., Tulsa, Okla....'28
‖Griffiths, J. C., Geol. Dept., Trinidad Leaseholds, Ltd., Pointe-a-Pierre. Trinidad, B.W.I....'41
Grigsby, Garland O., 1836 Irving Pl., Shreveport, La....'28
Grigsby, R. B., 2810 E. Twenty-sixth St., Tulsa, Okla....'24
Griley, Horace L., Sun Oil Co., 1608 Walnut St., Philadelphia, Pa....'24
Grimes, Russell W., Box 814, Taylor, Tex....'27
Grimsdale, Thomas F., Caribbean Petr. Co., Maracaibo, Venezuela, S. A....'37
Grinsfelder, Sam, 2027 University Blvd., Houston, Tex....'24
Griswold, E. H., Star Route, Odessa, Tex....'40
‖Grobecker, Alan John, Tide Water Assoc. Oil Co., Los Angeles, Calif....'42
Grogan, Samuel A., Gulf Oil Corp., Box 2100, Houston, Tex....'24
Grosjean, Robert, Brown & Wheeler, Inc., 1338 Commerce Bldg., Houston, Tex...'40
Gross, A. B., Mid-Continent Petr. Corp., 804 Alamo Natl. Bldg., San Antonio, Tex.'28
Gross, Henry Emmett, The Park Central, 443 Wrightwood Ave., Chicago, Ill....'36
‖Grossman, William L., 88 Hedgegarth Dr., Rochester, N. Y....'40
Grove, B. H., Socony-Vacuum Oil Co., Rm. 1700, 26 Broadway, New York, N. Y.'37
Grubb, Carl F., Carter Oil Co., Jackson, Miss....'37
Grubbs, David M., Shell Oil Co., Inc., Box 1347, Shreveport, La....'20
Gude, Leo J., Rm. 1203, 900 Polk St., Amarillo, Tex....'30
‖Gueno, Albert Jules, Jr., 1223 Avenue E, Crowley, La....'40
Guerrero, Alberto Lobo-, consulting engineer, Apt. 666, Bogota, Colombia, S. A...'31
Guinn, Delmar R., Cities Service Oil Co., Tyler, Tex....'29
Gulley, M. Gordon, Gulf Oil Corp., Box 1166, Pittsburgh, Pa....'25
‖Gully, Philip D., Box 1010, Beeville, Tex....'37
Gunter, Herman, Florida Geol. Survey, Conservation Dept., Tallahassee, Fla....'21
Guntz, Henry A., Kuwait Oil Co., Ltd., Kuwait, Arabia....'40
Guseman, L. F., The Texas Co., Box 2332, Houston, Tex....'38
Gutenberg, Beno, Seismological Laboratory, 220 N. San Rafael Ave., Pasadena, Calif....'31
‖Guthrie, Robert K., U. S. Bur. of Mines, 551 Federal Bldg., Dallas, Tex....'38
‖Gutru, Robert J., Cities Service Oil Co., Great Bend, Kan....'40
Gutzwiller, Otto, Bremgarten, Aargau, Switzerland....'28
Guyod, Hubert, Halliburton Oil Well Cementing Co., Box 2535, Houston, Tex....'37
‖Gwinn, J. William, West India Oil Co., San Jose, Costa Rica....'38

Haanstra, Ulco, United British Oilfields, Ltd., Point Fortin, Trinidad, B.W.I....'41
Haase, Fred M., Shell Oil Co., Inc., 415 Alexander Bldg., Abilene, Tex....'26
‖Hackbarth, Robert Earle, Box 53, Sealy, Tex....'41
‖Hackett, Robert Snowden, General Petr. Corp., 6 Crites Bldg., Bakersfield, Calif..'37
‖Hadley, Herbert D., Walker Museum, Univ. of Chicago, Chicago, Ill....'41
Hadley, Wade H., Jr., Pure Oil Co., Baton Rouge, La....'36
‖Haenke, M. Churchill, 885 S. Lucerne Blvd., Los Angeles, Calif....'39
Hafner, W., Shell Oil Co., Inc., Box 2099, Houston, Tex....'26
Hagan, Arthur M., c/o Hagan & Stewart Oil Co., 837 Nixon Bldg., Corpus Christi, Tex....'25
‖Hagan, Wallace W., consulting, 506 S. Gregory, Urbana, Ill....'38
Hageman, Donald E., 104 Spruce St., Billings, Mont....'23
Hagen, Cecil Vernon, consulting, 2901 Gulf Bldg., Houston, Tex....'31
Hager, Dilworth S., 932 Liberty Bank Bldg., Dallas, Tex....'22
Hager, Dorsey, consulting, Box 374, Centralia, Ill....'19
Hager, Lee, The Federal Royalty Co., 1521 Esperson Bldg., Houston, Tex....'18
Hagy, Lawrence R., c/o Hagy, Harrington & Marsh, 801 Amarillo Bldg., Amarillo, Tex....'25
Haigh, Berte R., University Lands, Box 1663, Midland, Tex....'31
Haight, Harold W., Standard Oil Co. of Egypt, 22 Sharia Kasr el Nil, Cairo, Egypt..'27
Haines, Richard B., Continental Oil Co., 601 W. Fifth St., Los Angeles, Calif....'38
Hake, Benjamin F., Gulf Refg. Co., Box 106, Indianapolis, Ind....'26

‖Hakes, Willard R., Box 67, Ackerly, Tex.....'40
Halbouty, M. T., consulting, #5 W. Lane, Houston, Tex.....'31
‖Hale, John D., Superior Oil Co., 313 Sill Bldg., Bakersfield, Calif.....'39
Hall, Dollie Radler, Amerada Petr. Corp., Drawer 2040, Tulsa, Okla.....'21
Hall, Ellis A., Box 274, Abilene, Tex.....'25
Hall, Elwin B., The Hall-Baker Co., 523 W. Sixth St., Los Angeles, Calif.....'24
Hall, Roy H., consulting, 270 S. Dellrose, Wichita, Kan.....'18
‖Hall, Thomas O., General Geophysical Co., 2513–14 Gulf Bldg., Houston, Tex.....'39
Halsted, Morris E., Amerada Petr. Corp., 1811 Esperson Bldg., Houston, Tex.....'30
Hamill, James M., The Texas Co., 929 S. Broadway, Los Angeles, Calif.....'29
Hamilton, C. E., Engineers Oil Co., 1916 N. Drexel, Oklahoma City, Okla.....'28
Hamilton, Charles W., 17 Battery Pl., 16th Floor, New York, N. Y.....'20
‖Hamilton, Edward A., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'41
‖Hamilton, Irving Boyd, 114 Breeze Terrace, Madison, Wis.....'40
‖Hamilton, James R., Geol. Dept., Mene Grande Oil Co., Apt. 234, Maracaibo, Venezuela, S. A.....'40
Hamilton, Robert G., Schlumberger Well Surveying Corp., 729 Natl. Bank of Tulsa Bldg., Tulsa, Okla.....'35
Hamm, W. Dow, Shell Oil Co., Inc., Box 2099, Houston, Tex.....'22
Hamman, John, Jr., 2131 San Felipe Rd., Houston, Tex.....'30
Hammond, Weldon W., 1704 Alamo Natl. Bldg., San Antonio, Tex.....'31
‖Hammonds, G. Scott, oil producer, Hotel Marshall, Marshall, Tex.....'40
Hamner, Edward John, Humble Oil & Refg. Co., Houston, Tex.....'42
‖Hamner, Francis M., 539½ Chautauqua, Norman, Okla.....'42
Hancock, Bob, Magnolia Petr. Co., Box 1828, Oklahoma City, Okla.....'30
Hancock, J. M., Southern Minerals Corp., 411 N. Broadway, Corpus Christi, Tex.....'31
Hancock, William T., Jr., Box 1745, Houston, Tex.....'30
‖Hand, H. D., Shell Oil Co., Inc., Box 426, Evansville, Ind.....'39
‖Hanes, Vincent Eugene, Montana School of Mines, Butte, Mont.....'41
Hanna, G. Dallas, California Academy of Sciences, San Francisco, Calif.....'24
Hanna, Marcus A., Gulf Oil Corp., Box 2100, Houston, Tex.....'25
‖Hansard, Charles O., Jr., The Ohio Oil Co., Houston, Tex.....'38
Hansell, James M., Box 2431, Corpus Christi, Tex.....'35
‖Hanson, Malcolm B., Phillips Petr. Co., Esperson Bldg., Houston, Tex.....'40
‖Harbison, Robert R., Stanolind Oil & Gas Co., 1410 Fair Bldg., Fort Worth, Tex.....'39
Hard, Edward W., Sun Oil Co., Old Natl. Bank Bldg., Evansville, Ind.....'30
Harden, Lynn L., Sinclair Prairie Oil Co., Box 1110, Tyler, Tex.....'28
‖Harder, Banhart Pete, Henrietta, Tex.....'42
Hardin, Clifford G., Mene Grende Oil Co., Apt. 45, Barcelona, Venezuela, S. A.....'39
‖Hardin, George C., Jr., Dept. of Geology, Univ. of Wisconsin, Madison, Wis.....'42
Hardin, V. A., independent, 629 Oneonta St., Shreveport, La.....'39
Hardison, George P., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'32
Hardison, Harvey, 5003 Crawford, Houston, Tex.....'35
Hardy, Norman, 509 Weldon Ave., Fresno, Calif.....'27
‖Hardy, William McC., consulting, 2400 Broadway, Little Rock, Ark.....'39
Hares, C. J., The Ohio Oil Co., Casper, Wyo.....'23
‖Haring, Louis H., Jr., 1106 McCullough Ave., San Antonio, Tex.....'39
Harkins, T. I., Independent Exploration Co., 2011 Esperson Bldg., Houston, Tex.....'37
Harley, G. Townsend, Union Potash & Chemical Co., Box 952, Carlsbad, N. Mex.....'33
Harlowe, Leslie S., Amerlagene, Inc., Shreveport, La.....'21
Harlton, Bruce H., Amerada Petr. Corp., Drawer 2040, Tulsa, Okla.....'27
Harper, O. C., c/o York & Harper, Inc., Box 971, Midland, Tex.....'21
Harrell, David C., Drawer 1490, Jackson, Miss.....'29
Harrell, Marshall A., 228 Blue Bonnet Blvd., San Antonio, Tex.....'27
Harrington, George H., c/o Buchanan & Harrington, 1524 Esperson Bldg., Houston, Tex.....'29
Harrington, George L., Tartagal, F.C.C.N.A., Pcia de Salta, Argentina, S. A.....'24
‖Harris, D. B., Box 142, Mt. Carmel, Ill.....'40
*Harris, Gilbert D., Dept. of Geology, Cornell University, Ithaca, N. Y.....'35
‖Harris, Lloyd A., Carter Oil Co., Box 43, St. Elmo, Ill.....'41
Harris, R. Merrill, Union Sulphur Co., Box 2385, W. Jackson, Miss.....'36
Harris, Richard C., Atlantic Refg. Co., 260 Broad St., Philadelphia, Pa.....'25
Harris, S. F., 1224 S. Elgin, Tulsa, Okla.....'27

Harris, Sidon, Stanolind Oil & Gas Co., Box 1410, Fort Worth, Tex.....'40
‖Harrison, John W., Argo Oil Corp., 211½ N. Colorado, Midland, Tex.....'39
Harrison, Thomas S., consulting, 1104 First Natl. Bank Bldg., Denver, Colo.....'19
Harriss, Trewhitt, Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif....'29
‖Hart, Raymond M., Louark Prod. Co., Box 150, Magnolia, Ark.....'39
Hartley, Burton, Military Dept., Texas A. & M. College, College Station, Tex.....'17
Hartwell, Moreland T., Mid-Continent Petr. Corp., Box 830, Midland, Tex.....'34
Harvey, Castle J. C., Amerada Petr. Corp., Esperson Bldg., Houston, Tex.....'36
Harvey, William W., consulting, 524–525 Milam Bldg., San Antonio, Tex.....'26
Haskell, N. A., Box 344, Bass River P.O., Cape Cod, Mass.....'41
Hasselmann, Karl F., Salt Dome Oil Corp., 19th Floor, Mellie Esperson Bldg., Houston, Tex.....'26
Hastings, Wynne K., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa.....'35
Hatcher, Oscar, Mid-Continent Petr. Corp., Tulsa, Okla.....'27
Hatfield, Willis Charles, Texas Petr. Co., Apt. Postal 877, Bogota, Colombia, S. A...'40
‖Hatheway, Joseph G., Schlumberger-Surenco, c/o M.G.O.C., Apt. 45, Barcelona, Venezuela, S. A.....'41
Hauptman, Herman R., 1648 Wilson, Wichita Falls, Tex.....'37
‖Hawes, Julian, Box 363, Magnolia, Ark.....'39
‖Hawk, William C., Rt. 1, Box 436, Ventura, Calif.....'40
‖Hawkes, Wendall H., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla.....'41
Hawkins, Glenn D., consulting, 739 Kennedy Bldg., Tulsa, Okla.....'28
Hawley, Henry J., Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif...'24
‖Hawley, L. David, The Texas Co., Box 1737, Shreveport, La.....'41
Hay, Lawrence, consulting, 1223 Union Natl. Bank Bldg., Wichita, Kan.....'21
Hayes, Albert O., Rutgers University, New Brunswick, N. J.....'21
Haynes, Winthrop P., Standard Oil Co. of N. J., Rm. 2150, 30 Rockefeller Plaza, New York, N. Y.....'17
Hazzard, John C., Union Oil Co. of Calif., 617 W. Seventh St., Los Angeles, Calif...'38
Hazzard, Roy T., Gulf Refg. Co. of Louisiana, Shreveport, La.....'25
Headington, Clare W., independent, 5036 Airline Rd., Dallas, Tex.....'39
Headley, Joseph B., Southern Petr. Explorations, Inc., Box 1017, Roswell, N. Mex..'25
Heald, K. C., Gulf Oil Corp., Box 1166, Pittsburgh, Pa.....'17
‖Heap, George E., Farmersburg, Ind.....'41
Heater, W. E., 1040 Ardmore Ave., Oakland, Calif.....'31
Heath, Francis E., Sun Oil Co., Box 2880, Dallas, Tex.....'24
‖Heathman, Jack H., Gulf Oil Corp., 1107 Union Natl. Bank Bldg., Wichita, Kan..'39
Heathman, Walter W., Union Oil Co. of Calif., 815 Union Natl. Bank Bldg., Wichita, Kan.....'36
Heaton, A. H., Sinclair Prairie Oil Co., Box 480, Corpus Christi, Tex.....'30
Heaton, R. L., Box 483, Estes Park, Colo.....'20
Heck, Edward T., W. Virginia Geol. Survey, 219 Chemistry Bldg., Morgantown, W. Va.....'38
Hedberg, Hollis D., Mene Grande Oil Co., Apt. 45, Barcelona, Venezuela, S. A.....'26
Hedley, J. David, Barnsdall Oil Co., 2212 Esperson Bldg., Houston, Tex.....'25
Hedrick, O. F., Texas Pacific Coal & Oil Co., Midland, Tex.....'23
Heeren, Julius A., 3117 S. Detroit, Tulsa, Okla.....'40
Heggblom, J. Conrad, Box 1062, Modesto, Calif.....'37
Hegwein, Walter H., Astra Romana S. A., Campina, Roumania.....'30
Heid, Gordon W., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'27
Heiland, Carl A., Colorado School of Mines, Golden, Colo.....'28
‖Helis, James, 2002 American Bank Bldg., New Orleans, La.....'41
Helmig, Phil D., 1414 N. Piedras St., El Paso, Tex.....'37
Hemmings, H., Lensbury Club, Broom Rd., Teddington, Middlesex, England.....'27
Hemphill, Herbert A., Geol. Dept., Magnolia Petr. Co., Box 1238, Midland, Tex...'31
Hemsell, Clenon C., Columbian Fuel Corp., 807 Rule Bldg., Amarillo, Tex.....'33
Henbest, Lloyd G., U. S. Natl. Museum, Rm. 327, Washington, D. C.....'31
Henderson, Charles W., U. S. Bureau of Mines, 615 Custom House, Denver, Colo...'25
Henderson, H. H., producer, 525 Milam Bldg., San Antonio, Tex.....'24
Henderson, Marion Reece, General Geophysical Co., 2513–14 Gulf Bldg., Houston, Tex.....'42
Henderson, W. D., Stanolind Oil & Gas Co., 917 Oliver-Eakle Bldg., Amarillo, Tex..'29
Hendricks, Leo, Bur. of Economic Geology, Univ. of Texas, Box 1534, Austin, Tex..'40

Hendricks, Thomas A., U. S. Geol. Survey, Washington, D. C.....'35
Hendrickson, Robert D., Tide Water Assoc. Oil Co., Box 1404, Houston, Tex.....'40
Hendrickson, Victor J., consulting, 1703 Williams St., Denver, Colo.....'23
‖Hendy, William J., Jr., 2521 Drummond St., Vicksburg, Miss.....'42
Hengst, Jess H., Box 396, Bridgeport, Ill.....'38
Heninger, Dan D., The Ohio Oil Co., 615 Hamilton Bldg., Wichita Falls, Tex.....'29
Hennen, Ray V., Patterson Hotel, Bismarck, N. Dak.....'19
Henny, Gerard, consulting, 647 Subway Terminal Bldg., Los Angeles, Calif.....'23
Henquet, Roger, Schlumberger Well Surveying Corp., 3611 Long Beach Blvd., Long Beach, Calif.....'35
Henry, Leonard W., Richmond Petr. Co. of Colombia, Apt. Nac. 2760, Bogota, Colombia, S. A.....'30
Henry, Schuyler B., Richmond Petr. Co. of Colombia, Apt. Nac. 2760, Bogota, Colombia, S. A.....'25
Henry, W. W., Continental Investment Corp., 1015 Kennedy Bldg., Tulsa, Okla..'20
‖Hensch, C. R., The California Co., Houston, Tex.....'40
Henson, F. R. S., Iraq Petr. Co., Ltd., Box #1, Kirkuk, Iraq.....'32
Henson, G. R., Bay Oil Corp., 911 Commercial Bank Bldg., Shreveport, La.....'24
Herald, Frank A., Ebasco Services, Inc., 2 Rector St., New York, N. Y.....'21
Herald, J. M., Cleo Springs, Okla.....'17
‖Herd, John Harvey, Standard Oil Co. of Texas, Midland, Tex.....'38
Herndon, Harold D., 915 Milam Bldg., San Antonio, Tex.....'29
Herold, C. Lathrop, Shell Oil Co., Inc., Box 2099, Houston, Tex.....'36
‖Herold, John S., U.S.N.R., U.S.S. Wm. P. Biddle, c/o The Postmaster, New York, N. Y.....'37
Herold, Stanley C., consulting, 1330 Ethel St., Glendale, Calif.....'19
Heroy, William B., Pilgrim Expl. Co., 1405 Second Natl. Bank Bldg., Houston, Tex.....'22
‖Heroy, William B., Jr., The Texas Co., Box 1720, Fort Worth, Tex.....'41
Herrick, Henry N., Standard Oil Co., 1300 Standard Oil Bldg., San Francisco, Calif.....'27
Herring, L. B., 701–2 Driscoll Bldg., Corpus Christi, Tex.....'29
Hertel, Francis W., Tide Water Assoc. Oil Co., Ventura, Calif.....'25
Hervey, O. S., Sun Oil Co., Box 368, Madisonville, Tex.....'37
Hestbeck, Marion E., Amerada Petr. Corp., Box 896, Shawnee, Okla.....'38
Heston, J. Ed, Office of Prod. Management, Sr. Petr. Tech., 7 Walnut St., Alexandria, Va.....'35
Hewett, Charles F., 319 Beacon Bldg., Tulsa, Okla.....'37
Hewitt, Robert Leigh, Tide Water Assoc. Oil Co., Rt. 1, Box 197-X, Bakersfield, Calif.....'42
Heyl, George Richard, consulting, 1518 Welch St., Little Rock, Ark.....'41
Hickey, Harold N., The California Co., 1816 Canal Bldg., New Orleans, La.....'24
‖Hicklin, Richard S., Carter Oil Co., Evansville, Ind.....'39
Hicks, I. Curtis, 2608 N. Thirty-first St., Oklahoma City, Okla.....'41
Hier, Charles Douglas, Seismograph Service Corp., Houston, Tex.....'41
Hiestand, Thomas C., Cities Service Oil Co., Bartlesville, Okla.....'25
‖Higgins, George Esmond, Trinidad Leaseholds, Ltd., Port of Spain, Trinidad, B.W.I.....'40
Higgs, Morton T., Lane-Wells Co., Box 1407, Houston, Tex.....'24
Hill, Harry B., U. S. Bur. of Mines, 551 Federal Bldg., Dallas, Tex.....'26
Hill, Mason L., Richfield Oil Corp., 312 Professional Bldg., Bakersfield, Calif.....'37
Hill, Orval H., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'37
‖Hill, Robert Grant, Rt. 9, Minneapolis, Minn.....'40
Hill, V. G., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla.....'28
‖Hiller, C. F., The Texas Co., Box 600, Wichita Falls, Tex.....'41
Hillis, Donuil L., Capital Co., 1 Powell St., San Francisco, Calif.....'26
Hills, John M., consulting, Box 418, Midland, Tex.....'35
Hilseweck, William J., Gulf Oil Corp., Box 1290, Fort Worth, Tex.....'38
Hilton, Willard O., Box 705, Diablo Heights, Panama Canal Zone.....'37
Hindes, E. P., Petroleum Advisers, Inc., 70 Pine St., New York, N. Y.....'17
Hinds, Henry, Greenwich Towers, Greenwich, Conn.....'19
Hinson, Hillord, Harrison Oil Co., 2105 Gulf Bldg., Houston, Tex.....'36

Hintze, A. J., Phillips Petr. Co., Bartlesville, Okla.....'38
Hirsch, Jack, The Texas Co., Box 476, Mattoon, Ill.....'38
‖Hitchcock, Edmund S., c/o E. C. Hitchcock & Son, Box 774, Midland, Tex.....'40
Hlauschek, H., Romano Americana, Teleajen Works, Ploesti, Roumania.....'30
Hoard, J. O., Hoard Expl. Co., 618 Esperson Bldg., Houston, Tex.....'35
Hobson, H. D., General Petr. Corp., 6 Crites Bldg., Bakersfield, Calif.....'30
Hockman, James N., Box 14, Benton, Ill.....'24
Hodder, Roland F., Brown Geophysical Co., Box 6005, Houston, Tex.....'40
Hoenshell, David T., Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B.W.I..'26
Hoffer, Clarence W., 323 S. Fairfax St., Alexandria, Va.....'23
Hoffman, Arnold D., 1617 Hyde Park Blvd., Chicago, Ill.....'39
Hoffman, Charles C., Cities Service Gas Co., 705 Masonic Bldg., Bartlesville, Okla..'20
Hoffman, Malvin G., 3821 W St., S.E. (Fairfax Village), Washington, D. C.....'21
Hoffmann, Charles R., Chef de Mission des Petroles, Boma, Congo Belge (Mail returned).....'27
Hoffmeister, William S., Carter Oil Co., Shreveport, La.....'28
Hogan, Dana, c/o Hogan Petr. Co., 714 W. Olympic Blvd., Los Angeles, Calif.....'27
Hoke, Charles J., Phillips Petr. Co., 413 American Trust Bldg., Evansville, Ind.....'38
Hoke, T. C., I.T.I.O. Co., Bartlesville, Okla.....'29
‖Holden, Frederick T., Carter Oil Co., Jena, La.....'41
Holden, Roy J., Polytechnic Institute, Blacksburg, Va.....'25
Holl, F. G., consulting, 4121 E. English, Wichita, Kan.....'21
‖Holland, Aaron E., 51 Washington Ave., Schenectady, N. Y.....'41
Holland, Laurier F. S., Box 191, Placerville, Calif.....'27
‖Holland, Richard M., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'38
Hollingsworth, R. V., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'32
Hollister, Joseph S., Belvedere, Marin County, Calif.....'37
Holloman, Roy, Raylane Hotel, Denver, Colo.....'21
Holman, Eugene, Standard Oil Co. of N. J., Rm. 2766, 30 Rockefeller Plaza, New York, N. Y.....'20
Holman, W. H., 4125 Tilden Ave., Culver City, Calif.....'27
‖Holmer, Ralph C., Mott-Smith Corp., 909 Shell Bldg., Houston, Tex.....'39
Holmes, S. W., 630 N. Fountain, Wichita, Kan.....'28
Holston, A. A., Stanolind Oil & Gas Co., Box 689, Jackson, Miss.....'38
Holston, Ashly S., Tide Water Assoc. Oil Co., 891 Pacific Electric Bldg., Los Angeles, Calif.....'37
Honess, Charles W., Gulf Refg. Co., Box 774, Evansville, Ind.....'17
Hood, Forrest W., The Ohio Oil Co., Jackson, Miss.....'28
Hook, Joseph S., Union Oil Co. of Calif., Los Angeles, Calif.....'19
Hoots, Harold W., Richfield Oil Corp., 430 Richfield Bldg., Los Angeles, Calif.....'21
Hoover, F. Mabry, Cities Service Oil Co., Box 4577, Oklahoma City, Okla.....'27
Hoover, Herbert, Jr., United Geophysical Co., 1255 E. Green St., Pasadena, Calif.'40
Hoover, J. W., The California Co., Canal Bldg., New Orleans, La.....'28
Hoover, James B., Olson Drilling Co., Drawer 588, Tulsa, Okla.....'29
Hoover, Malvern E., c/o Andrew Yule & Co., 8 Clive Row, Calcutta, India.....'38
Hoover, W. Farrin, 409 S. E. First St., Evansville, Ind.....'37
Hoover, William B., Humble Oil & Refg. Co., 538 Amarillo Bldg., Amarillo, Tex...'25
Hopkins, Oliver B., Imperial Oil Co., 56 Church St., Toronto, Ont., Canada.....'21
‖Hopkins, Richard H., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa.....'38
‖Hopper, Richard H., Nederlandsche Pac. Petr. Mij., Kebon Sirah 52, Batavia C, Java, N.E.I.....'40
Hopper, Walter E., consulting, 512 Natl. Mutual Bldg., Tulsa, Okla.....'20
‖Hord, John Alan, Gulf Oil Corp., Box 1734, Midland, Tex.....'41
Horkey, William E., 1915 E. Wheeling, Tulsa, Okla.....'27
Hornberger, Joseph, Jr., The Texas Co., Box 2332, Houston, Tex.....'30
Horner, William L., Core Laboratories, Inc., 415 Niels Esperson Bldg., Houston Tex.....'36
Hornkohl, Frank, Chemical Laboratory, Box 1673, Bakersfield, Calif.....'41
‖Hornung, A. C., Carter Oil Co., Box 429, Ponca City, Okla.....'40
Horton, Harold M., 521 Citizens Bank Bldg., Evansville, Ind.....'26
Horvitz, Leo, Subterrex, 701 Waugh Dr., Houston, Tex.....'40
Hosterman, John F., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'25
Hotchkiss, Henry, Basrah Petr. Co., Ltd., Box 21, Basrah, Iraq.....'39

Housh, C. N., c/o Housh & Thompson, Inc., Gulf Bldg., Houston, Tex.....'24
Houston, Sam H., Jr., Humble Oil & Refg. Co., Hattiesburg, Miss.....'31
Howard, Arthur Henry, St. Helen's Court, Leadenhall St., London, E. C. 3, England.....'24
Howard, Dan O., Oklahoma Corporation Commission, Oklahoma City, Okla.....'28
Howard, Douglas D., Penrod Drilling Co., Box 328, Good Pine, La.....'37
Howard, Edward L., Howard Petr. Corp., 610 Citizens Natl. Bank Bldg., Tyler, Tex.'33
‖Howard, George C., Box 622, Norman, Okla.....'40
Howard, Paul J., 101 Flower St., Bakersfield, Calif.....'39
Howard, W. V., The Oil & Gas Journal, Box 1260, Tulsa, Okla.....'29
Howe, Henry V., Louisiana State Univ., Geol. Dept., Baton Rouge, La.....'23
‖Howe, Ralph H., Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex.....'41
Howell, J. V., 1606 Swan Dr., Tulsa, Okla.....'17
Howell, W. F., 707 Litchfield St., Wichita, Kan.....'21
Howells, W. C., McColl-Frontenac Oil Co., Ltd., 701 Lancaster Bldg., Calgary, Alta., Canada.....'40
Howeth, Irving K., 746 Milam Bldg., San Antonio, Tex.....'26
Hoyle, Charles R., 201 W. Franklin St., Shawnee, Okla.....'23
Hoyt, William V., independent, Box 541, Houston, Tex.....'21
Hruby, Milton, Magnolia Petr. Co., Box 128, Mattoon, Ill.....'30
Hubbard, Bela, Standard Oil Co. of N. J., 30 Rockefeller Plaza, New York, N. Y. '27
Huber, John Norris, Continental Oil Co., 601 W. Fifth St., Los Angeles, Calif.....'41
Hubley, Myron D., Box 361, Garden City, Kan.....'39
Hubman, Carl W., Colombian Petr. Co., Apt. Postal 100, Cucuta, Colombia, S. A. '29
Hubman, Ralph G., The Texas Co., Box 14, Wheeling, W. Va.....'35
Huddle, John Warfield, Univ. of N. Carolina, Chapel Hill, N. C.....'38
Hudgens, Clyde O., Gulf Oil Corp., Box 661, Tulsa, Okla.....'37
Hudnall, James S., c/o Hudnall & Pirtle, Box 988, Tyler, Tex.....'27
Hudson, Frank S., Yuba Consolidated Gold Fields, 315 California St., San Francisco, Calif.....'23
Hudson, Oscar M., 1407 E. Twenty-first St., Tulsa, Okla.....'39
Hudson, William A., Emperor Oil Co., 1810 Electric Bldg., Fort Worth, Tex.....'26
‖Hudson, W. T., Richmond Petr. Co. of Colombia, Edificio Clavijo, Bogota, Colombia, S. A.....'39
Huey, Arthur S., Shell Oil Co., Inc., Box 999, Bakersfield, Calif.....'41
Huffman, Edward A., Skelly Oil Co., Box 287, Falls City, Neb.....'38
‖Huffmyer, Jack Roach, Subterrex, 701 Waugh Dr., Houston, Tex.....'40
Hughes, Aden Wayne, Union Oil Co. of Calif., Bakersfield, Calif.....'40
Hughes, C. Don, consulting, 1901 Van Buren St., Amarillo, Tex.....'21
Hughes, Darrell S., Geophysical Section, Shell Oil Co., Inc., Houston, Tex.....'40
Hughes, Donald D., 1817 El Rito Ave., Glendale, Calif.....'24
Hughes, Richard, 1376 E. Twenty-sixth St., Tulsa, Okla.....'19
Hughes, Richard V., Office of Petr. Coordinator for Natl. Defense, Washington, D. C.....'30
Hughes, Urban B., consulting, 105½ W. Capitol St., W. Jackson, Miss.....'20
Hulin, Carlton D., Univ. of California, Bacon Hall, Berkeley, Calif.....'25
Hull, J. P. D., The American Association of Petroleum Geologists, Box 979, Tulsa, Okla.....'20
Hulsewe, Gerard Jan, Standard Oil Co. of Calif., Box 1200, Bakersfield, Calif.....'37
Hume, George S., Geological Survey of Canada, Ottawa, Ont., Canada.....'27
Huner, John, Jr., Louisiana Geol. Survey, Baton Rouge, La.....'38
Hunt, Edwin H., McColl-Frontenac Oil Co., Ltd., 707 Lancaster Bldg., Calgary, Alta., Canada.....'24
Hunt, Lenora May, Amerada Petr. Corp., Drawer 2040, Tulsa, Okla.....'31
‖Hunt, Leo Frank, R. R. 2, Box 68, Leigh, Neb.....'39
Hunt, Raymond S., 2333 Collingwood Ave., S.W., Wyoming Park, Grand Rapids, Mich.....'25
Hunter, Campbell M., "Hazelwell," Oxshott, Surrey, England.....'27
Hunter, Coleman D., Kentucky-W. Virginia Gas Co., 608 Second Natl. Bank Bldg., Ashland, Ky.....'30
Hunter, Harry M., 1419 Ninth St. West, Calgary, Alta., Canada.....'28
Hunter, James W., Apt. 111, Ciudad Tujillo, Dominican Republic.....'27
Hunter, Paul B., 3068 Reba Dr., Houston, Tex.....'24

Hunter, R. Lee, Continental Oil Co., Ponca City, Okla.....'31
Huntley, Louis G., c/o Huntley & Huntley, Victoria Rd., Donna, Tex.....'19
‖Huntley, Louis Guy, Standard Oil Co. of Venezuela, Apt. 1329, Caracas, Venezuela, S. A.....'38
Hunzicker, A. A., Box 328, Harrisburg, Ill.....'34
Hunzicker, Vernon J., Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex.....'37
Hupp, John Ervin, Glacier Production Co., Cut Bank, Mont.....'26
‖Hurd, E. Gordon, Geol. Dept., Continental Oil Co., Denver, Colo.....'41
‖Hurry, Phil, 1119 N. W. Thirty-seventh St., Oklahoma City, Okla.....'41
‖Hussey, Keith M., Dept. of Geology, Univ. of Houston, Houston, Tex.....'40
Hutchinson, Frederick M., 1903 Second Natl. Bank Bldg., Houston, Tex.....'24
Hutchison, Arthur G., B. O. C., Khodaung, Upper Burma.....'39
Hutson, E. B., Carter Oil Co., Shreveport, La.....'24
Hyatt, Don L., Carter Oil Co., Box 1151, Seminole, Okla.....'36
Hyde, Ben Cooper, Box 1846, Midland, Tex.....'40
Hyde, Clarence E., 1715 W. T. Waggoner Bldg., Fort Worth, Tex.....'23

Iddings, Arthur, International Petr. Co., Ltd., Apt. 1081, Lima, Peru, S. A.....'19
Igau, Hubert C., Superior Oil Co. of Calif., Houston, Tex.....'34
Iki, Tsunenaka, 525 Kita-Senzoku-Cho Omoriku, Tokyo, Japan.....'24
‖Ikins, William Clyde, Tide Water Assoc. Oil Co., Box 1404, Houston, Tex.....'42
‖Iles, George, Jr., 507 N. Pine, De Ridder, La.....'40
Illing, Vincent C., Links Corner, Ashtead, Surrey, England.....'34
Imbt, Robert F., consulting, 604 Trinity Life Bldg., Fort Worth, Tex.....'23
Imbt, William C., Standard Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan.....'31
‖Ingham, A. I., Shell Oil Co., Inc., 2000 Alamo Natl. Bldg., San Antonio, Tex.....'40
Ingham, W. I., Gulf Refg. Co., Indianapolis, Ind.....'28
Inkster, John W., Shell Oil Co., Inc., 1009 Central Bldg., Wichita, Kan.....'37
Innes, Arland I., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'38
‖Irwin, Carl B., Navy Dept., Office of Inspector of Naval Material, 605 First Natl. Bank Bldg., Houston, Tex.....'40
Irwin, J. S., consulting, 812 Lancaster Bldg., Calgary, Alta., Canada.....'19
Irwin, Wallace W., c/o Culbertson & Irwin, Inc., Box 1071, Midland, Tex.....'30
Isaacs, Elizabeth, Cities Service Oil Co., 1020 Central Bldg., Wichita, Kan.....'29
Isberg, John T., The Ohio Oil Co., 417 S. Hill St., Los Angeles, Calif.....'38
Isenberger, N. P., Phillips Petr. Co., 703-11 Driscoll Bldg., Corpus Christi, Tex.....'25
Israelsky, Merle C., Union Prod. Co., 841 M & M Bldg., Houston, Tex.....'25
Ittner, Frank Edward, Superior Oil Co., Box 96, Bakersfield, Calif.....'41
‖Iversen, William G., Continental Oil Co., Huntsville, Tex.....'41
Ivy, John Smith, 3247 Inwood Dr., Houston, Tex.....'25

Jablonski, E., Socony-Vacuum Oil Co., Inc., Floor 1700, 26 Broadway, New York, N. Y.....'27
Jackson, Alvin M., Geol. Dept., Arkansas Fuel Oil Co., Shreveport, La.....'38
Jackson, J. R., Jr., Montgomery, Tex.....'38
‖Jager, Eric H., 235 N. Belmont, Wichita, Kan.....'42
Jakosky, J. J., School of Engineering & Architecture, Univ. of Kansas, Lawrence, Kan.....'41
‖James, Jay R., Dow Chemical Co., Midland, Mich.....'41
James, Wright E., Suite 310, Professional Bldg., Bakersfield, Calif.....'25
Jameson, M. H., 43 Bellewood Pl., Elizabeth, N. J.....'36
Jamison, Paul H., Jr., Darling Valve & Mfg. Co., Box 36, Altamont, Ill.....'38
Janovy, John, Louisiana Land & Expl. Co., Houma, La.....'36
Jay, Stanley E., c/o Gray & Wolf, 815 Second Natl. Bank Bldg., Houston, Tex.....'24
Jeffreys, Geoffrey, consulting, 100 E. Pearl St., Jackson, Miss.....'26
‖Jenkins, George Marvin, 419 Magazine St., Tupelo, Miss.....'41
Jenkins, Harold D., Kerlyn Oil Co., 338 Masonic Temple Bldg., Shawnee, Okla.....'37
Jenkins, Olaf P., California Div. of Mines, Ferry Bldg., San Francisco, Calif.....'28
‖Jenkins, Page T., Box 571, Eldorado, Ill.....'40
Jenks, William F., Cerro de Pasco Copper Corp., Cerro de Pasco, Peru, S. A.....'37
Jennings, Philip H., Magnolia Petr. Co., Box 111, Houston, Tex.....'34
Jenny, W. P., consultant, 1406 Sterling Bldg., Houston, Tex.....'26
Jensen, Frederick T., 1200 E. Noleman, Centralia, Ill.....'39

Jensen, Joseph, Tide Water Assoc. Oil Co., 888 Pacific Electric Bldg., Los Angeles, Calif.....'23
Joekel, Fred E., Magnolia Petr. Co., Box 900, Dallas, Tex.....'29
Johns, Wendell S., The Texas Co., Tulsa, Okla.....'36
Johnson, Clifton W., Richfield Oil Corp., 555 S. Flower St., Los Angeles, Calif.....'37
Johnson, Curtis H., 1136 Franklin St., Santa Monica, Calif.....'37
Johnson, E. L., consulting, 1829 W. Summit, San Antonio, Tex.....'29
‖Johnson, Edward W., The Ohio Oil Co., Box 266, Falls City, Neb.....'38
Johnson, Elton D., Stanolind Oil & Gas Co., Box 40, Casper, Wyo.....'39
‖Johnson, Frank Walker, Standard Oil Co. of Venezuela, San Joaquin Camp, Apt. 35, Barcelona, Venezuela, S. A.....'37
Johnson, Harry R., consulting, 1002 Edison Bldg., Los Angeles, Calif.....'23
‖Johnson, Holger Olin, Phillips Petr. Co., Box 844, Lake Charles, La.....'39
Johnson, J. Harlan, Colorado School of Mines, Golden, Colo.....'24
Johnson, Lester H., Geophysical Dept., Phillips Petr. Co., Bartlesville, Okla.....'37
Johnson, Russell V., consulting, 913 Lancaster Bldg., Calgary, Alta., Canada.....'20
Johnson, Walter, Adams Oil & Gas Co., Box 6, Yorktown, Tex.....'39
‖Johnston, Elizabeth Jane, 215 W. Seventh St., Rm. 1229, Los Angeles, Calif.....'40
‖Johnston, John C., Stanolind Oil & Gas Co., Box 1099, Shawnee, Okla.....'40
Johnston, Kenneth A., 612 Loews State Bldg., Los Angeles, Calif.....'28
Johnston, Leslie A., 409 Victoria Bank & Trust Bldg., Victoria, Tex.....'38
‖Johnston, Lois L., Gulf Oil Corp., Box 1290, Fort Worth, Tex.....'36
‖Johnston, Robert L., Stanolind Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan.....'41
Jolley, Durward N., independent consulting, 319 Nixon Bldg., Corpus Christi, Tex..'31
Jones, Boone, consulting, Box 493, Ada, Okla.....'21
Jones, Charles T., 728 E. Miami Ave., McAlester, Okla.....'29
Jones, Daniel J., State geologist, 1471 Tates Creek Rd., Lexington, Ky.....'40
Jones, Daniel J., Geol. Dept., Phillips Petr. Co., Bartlesville, Okla.....'38
Jones, Edward L., Jr., Box 345, Scottsdale, Ariz.....'22
‖Jones, J. Byron, Geol. Dept., Standard Oil Co. of Venezuela, Apt. 1329, Caracas, Venezuela, S. A.....'39
Jones, John Percy, Arkansas Fuel Oil Co., Shreveport, La.....'39
Jones, Leland W., 1603 E. Thirty-sixth St., Tulsa, Okla.....'35
Jones, Ogden S., Kansas State Board of Health, Engineering Bldg., Lawrence, Kan.'29
Jones, Park J., The Texas Co., Box 1720, Fort Worth, Tex.....'42
‖Jones, Paul Hastings, U. S. Geol. Survey, Ground Water Div., Box 8315, Baton Rouge, La.....'41
Jones, Robert L., Cities Service Oil Co., 2701 Esperson Bldg., Houston, Tex.....'40
Jones, Roy D., Ardie Oil & Gas Co., 2612 First Natl. Bldg., Oklahoma City, Okla..'23
Jones, Verner, Magnolia Petr. Co., Box 128, Mattoon, Ill.....'37
Jones, Walter B., Dept. of Conservation, Montgomery, Ala.....'28
Jones, Wayne V., Tide Water Assoc. Oil Co., Box 1404, Houston, Tex.....'33
‖Jopling, Don Winter, Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A.....'40
‖Jordan, J. B., Box 192, Konawa, Okla.....'42
‖Jordan, Lee Knight, 330 Serra St., Stanford University, Calif.....'39
Jordan, Louise, Sun Oil Co., Box 2880, Dallas, Tex.....41
Joujon-Roche, Jean Edward, 512 Fontaine St., Alexandria, Va.....'36
Jowett, M. W., Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B.W.I.....'42
‖Judson, J. F., Socony-Vacuum Oil Co., Apt. 246, Caracas, Venezuela, S. A.....'41
Judson, Sidney A., Texas Gulf Prod. Co., Houston, Tex.....'24
‖Judson, Wilbur, Texas Gulf Prod. Co., Newgulf, Tex.....'41
Junger, Arne, Box 599, Madera, Calif.....'30
Justice, Philip S., Sun Oil Co., Box 2831, Beaumont, Tex.....'22

Kalb, J. L., Rm. 2737, 30 Rockefeller Plaza, New York, N. Y.....'33
Kamb, Hugo R., Arkansas Companies, Box 1734, Shreveport, La.....'27
Kane, William G., consulting, Apt. 197, Saltillo, Coah., Mex.....'26
‖Kaplan, Lazard Harold, Box 1015, Alexandria, La.....'41
Karcher, John C., Coronado Corp., 406 Continental Bldg., Dallas, Tex.....'31
‖Karubian, Ruhollah Y., 998 Hemat Abad, Hassan Abad, Teheran, Iran.....'41
Kauffman, James S., Wilcox Oil & Gas Co., Box 1440, Tulsa, Okla.....'30
Kaufmann, Godfrey F., Standard Oil Co., of Venezuela, Apt. 1329, Caracas, Venezuela, S. A.....'25

Kautz, Archie R., Cities Service Gas Co., Box 350, Amarillo, Tex.....'20
Kay, Fred H., Standard Vacuum Oil Co., Rm. 1412, 26 Broadway, New York, N. Y..'19
Kay, G. Marshall, Dept. of Geology, Columbia University, New York, N. Y.....'29
Kay, John A., consulting, 701 Hamilton Bldg., Wichita Falls, Tex.....'29
Kaye, M. Kamen, Caracas Petr. S. A., Apt. 89, Caracas, Venezuela, S. A.....'35
‖Kearney, Clinton C., 710 Grayson St., San Antonio, Tex.....'40
Keeler, Clifton M., c/o Ray Stephens, Inc., 1716 First Natl. Bank Bldg., Oklahoma City, Okla.....'19
Keeler, William W., Box 772, Evansville, Ind.....'24
Kehrer, L., United British Oilfields of Trinidad, Ltd., 15 Abercromby St., Port of Spain, Trinidad, B.W.I.....'30
Keller, P. Hastings, consulting, 332 McKinley Rd., Grosse Point, Mich.....'26
Keller, Walter T., consulting, 53 Rublistrasse, Basle, Switzerland.....'27
Kelley, H. Allen, 2809 Alturas Dr., Bakersfield, Calif.....'28
‖Kelley, Frederick R., General Delivery, Belvedere, Calif.....'41
Kelley, Ward W., 199 Wyckham Dr., San Antonio, Tex.....'29
†Kellum, Lewis B., Museum of Paleontology, Ann Arbor, Mich.....'25
Kelly, Donald, The Texas Co., Box 600, Wichita Falls, Tex.....'24
‖Kelly, John S., Box 3128, Houston, Tex.....'40
‖Kelly, Robert B., Continental Oil Co., Los Angeles, Calif.....'41
Kelsey, Lewis O., Republic Nat. Gas Co., 1505 Federal St., Dallas, Tex.....'35
Kelsey, Martin, Geophysical Service, Inc., 1311 Republic Bank Bldg., Dallas, Tex..'34
Kemnitzer, Luis E., Financial Center Bldg., 704 S. Spring, Los Angeles, Calif.....'29
‖Kemp, Augusta Hasslock, Seymour High School, Box 626, Seymour, Tex.....'26
Kemp, H. S., 1504 Sterling Bldg., Houston, Tex.....'29
Kendrick, Frank E., Lone Star Gas Co., Dallas, Tex.....'20
‖Kennedy, Gilbert R., independent, 3238 Huntingdon Pl., Houston, Tex.....'30
Kennedy, J. B., 1306 Fort Worth Natl. Bank Bldg., Fort Worth, Tex.....'26
Kennedy, Joseph B., Jr., Sinclair Prairie Oil Co., Midland, Tex.....'36
Kennedy, Luther E., Peters Petr. Corp., Natl. Bank of Tulsa Bldg., Tulsa, Okla...'19
‖Kennett, William Eric, Box 164, Santa Paula, Calif.....'40
Keppler, Leo G., Lewis Production Co., 809 Alamo Natl. Bldg., San Antonio, Tex..'21
Kerbow, Russell B., Gulf Research & Dev. Co., Drawer 2038, Pittsburgh, Pa.....'30
Kerlin, M. L., Jr., Shell Oil Co., Inc., Slattery Bldg., Shreveport, La.....'35
‖Kerr, James Lee, Brown Geophysical Co., Box 6005, Houston, Tex.....'42
Kerr, John B., consulting, c/o Hawkins Bros., Foreman, Ark.....'20
Kerr, Richard C., 717 Fourteenth Ave., San Francisco, Calif.....'27
‖Kerstetter, Dale D., Standard Oil Co., of Venezuela, Apt. 1329, Caracas, Venezuela, S. A.....'39
Kesler, L. W., Sinclair Prairie Oil Co., 527 First Natl. Bank Bldg., Wichita, Kan...'19
‖Ketterer, Walter P., Gulf Refg. Co., Box 106, Indianapolis, Ind.....'41
Kew, W. S. W., Standard Oil Co., Box 2437, Terminal Annex, Los Angeles, Calif...'21
Kidd, Gentry, Stanolind Oil & Gas Co., 1132 Milam Bldg., San Antonio, Tex.....'29
Kidd, Robert L., Cities Service Oil Co., Bartlesville, Okla.....'26
Kiess, Myron C., Pure Oil Co., Box 271, Tulsa, Okla.....'27
‖Kilbourne, Lewis P., consultant, 617 Carondelet Bldg., New Orleans, La.....'41
Kilian, Harry, Union Sulphur Co., Inc., Sulphur, La.....'37
‖Kilkenny, John E., Pure Oil Co., Bakersfield, Calif.....'40
Kimball, Edgar W., Continental Oil Co., Box 1800, Wichita Falls, Tex.....'36
Kimball, Kent K., 1804 W. Easton St., Tulsa, Okla.....'22
Kimble, James C., General Petr. Corp., 6 Crites Bldg., Bakersfield, Calif.....'36
King, Charles C., Box 352, Tulsa, Okla.....'27
King, Philip B., U. S. Geol. Survey, Washington, D. C.....'25
King, Robert E., Shell Oil Co., Inc., Midland, Tex.....'31
King, Vernon L., 427 N. Fuller Ave., Los Angeles, Calif.....'23
‖King, Victor H., General Petr. Corp., 6 Crites Bldg., Bakersfield, Calif.....'38
Kinkel, W. C., The Ohio Oil Co., Box 552, Midland, Tex.....'23
‖Kinney, Douglas Merrill, 1702 N. El. Molino Ave., Pasadena, Calif.....'40
Kinney, Harry D., Research Dept., Chase Natl. Bank, 11 Broad St., New York, N. Y.....'24
Kinser, J. H., The California Co., 1818 Canal Bldg., New Orleans, La.....'42
Kipp, E. M., The California Co., Box 71, Gretna, La.....'38
Kirby, Grady, c/o Adams & Lyles, 1915 Alamo Natl. Bldg., San Antonio, Tex....'19
Kirby, James M., Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif...'27

Kirby, Louie C., Land Dept., Lion Oil Refg. Co., Exchange Bldg., El Dorado, Ark..'31
Kirk, Charles T., 1226 S. Newport, Tulsa, Okla.....'17
Kirk, Howard M., Box A-66, Port-au-Prince, Haiti.....'27
Kirkendall, James, Amerada Petr. Corp., Box 591, Midland, Tex.....'37
Kirkham, Virgil R. D., 1126 N. Michigan, Saginaw, Mich.....'30
Kisling, James W., Jr., Amerada Petr. Corp., 1811 Esperson Bldg., Houston, Tex...'27
Kister, Herbert H., Stanolind Oil & Gas Co., Tulsa, Okla.....'26
‖Kistler, Phillip S., General Petr. Corp., 6 Crites Bldg., Bakersfield, Calif.....'40
Kite, William C., 1916 First Natl. Bank Bldg., Oklahoma City, Okla.....'17
‖Kittredge, Frank R., 907 E. Thirteenth St., Cameron, Tex.....'27
Kittredge, M. B., 656 N. Beard St., Shawnee, Okla.....'25
‖Kivi, Wilho J., Box 175, Hanna, Wyo.....'39
‖Klabzuba, Robert E., Prague, Okla.....'40
Klaus, Hellmut, c/o Klaus Expl. Co., Box 1617, Lubbock, Tex.....'28
‖Klecker, John B., Atlantic Refg. Co. of Cuba, 401 Edificio la Metropolitana, Havana, Cuba.....'40
Kleeman, Albert P., Franco-Western Oil Co., Box 308, McKittrick, Calif.....'34
‖Kleen, Harold J., Skelly Oil Co., Tulsa, Okla.....'39
Kleinpell, Robert M., 675 S. Euclid Ave., Pasadena, Calif.....'29
Kleinpell, William D., consulting, Box 1131, Bakersfield, Calif.....'25
‖Kline, Robert W., Sinclair Wyoming Oil Co., Box 991, Seminole, Okla.....'41
Klingaman, George L., Standard Oil Co. of Calif., Box 97, Avenal, Calif.....'25
Klinger, E. D., Lion Oil Refg. Co., El Dorado, Ark.....'27
Kluth, Emil, c/o G. F. Getty, Inc., 1060 Subway Terminal Bldg., 417 S. Hill St., Los Angeles, Calif.....'27
Knappen, Russell S., Gulf Oil Corp., Box 661, Tulsa, Okla.....'20
Kneale, William C., The Texas Co., Box 218, Salem, Ill.....'27
Knebel, G. Moses, Standard Oil Co., Rm. 2753, 30 Rockefeller Plaza, New York, N. Y.....'24
Knechtel, M. M., U. S. Geol. Survey, Rm. 4230, N. Interior Bldg., Washington, D.C.'30
Knight, J. Brookes, Dept. of Geology, Princeton Univ., Princeton, N. J.....'31
‖Knight, Jack W., Superior Oil Co., Box 84, Taihape, N. Z.....'41
‖Knight, L. Clark, independent, Box 213, Great Bend, Kan.....'38
Kniker, Hedwig T., independent, 134 W. Agarita, San Antonio, Tex.....'21
Knipe, R. E., The Ohio Co., Owensboro, Ky.....'35
Knouse, W. Stanley, Tide Water Assoc. Oil Co., R. 1, Box 197-X, Bakersfield, Calif.'42
Knowlton, D. R., Graham-Loftus Oil Corp., Los Angeles, Calif.....'41
Knox, George L., Standard Oil Co., of Calif., San Francisco, Calif.....'27
Knox, John K., Phillips Petr. Co., Box 188, Seattle, Wash.....'19
Knox, T. K., Republic Nat. Gas Co., Dallas, Tex.....'29
Knutson, C. J., Ford, Bacon & Davis, Inc., Box 631, Meridian, Miss.....'27
Koch, Heinrich L., Shell Oil Co., Inc., Centralia, Ill.....'38
Koch, Richard E., Pangkalan Brandan, N. Sumatra, N.E.I.....'28
Koch, Thomas W., Standard Oil Co. of Texas, Midland, Tex.....'25
Koenig, Ralph A., The Ohio Oil Co., Findlay, Ohio.....'32
Koester, Edward A., Darby Petr. Corp., 802 Ellis Singleton Bldg., Wichita, Kan...'29
Kolm, Paul H., consulting, Box 337, Watonga, Okla.....'30
Kolm, Robert N., Atlantic Refg. Co., 1742 Milam Bldg., San Antonio, Tex.....'19
Konkel, Philip M., The Ohio Oil Co., 318 W. Ninth, Rochester, Ind.....'38
Kornfeld, M. M., consulting, 1818 Second Natl. Bank Bldg., Houston, Tex.....'27
‖Kornfeld, Sam, 1126 Union Natl. Bank Bldg., Wichita, Kan.....'35
Kotick, O. F., 144th F. A., Fort Lewis, Wash.....'35
Kotyza, Fred F., Tide Water Assoc. Oil Co., Box 181, Midland, Tex.....'38
‖Kovac, M. Stephen, Cities Service Oil Co., 1440 Mellie Esperson Bldg., Houston, Tex.....'40
Kraft, Philip, Alder Oil Co., Rm. 1501, 14 Wall St., New York, N. Y.....'27
Kramer, William B., U. S. Geol. Survey, 224 Custom House, Denver, Colo.....'26
Krammes, Kenneth F., 2617 Lake St., Bakersfield, Calif.....'39
Krampert, E. W., consulting, Box 1106, Casper, Wyo.....'23
Kraus, Edgar, Atlantic Refg. Co., Box 808, Carlsbad, N. Mex.....'20
Kravis, Raymond F., 530 Beacon Bldg., Tulsa, Okla.....'36
‖Kreidler, William Lynn, Tide Water Assoc. Oil Co., Giddens-Lane Bldg., Shreveport, La.....'40
Kribbs, George R., Bankline Oil Co., Los Angeles, Calif.....'39

Kridler, George M., Deep Rock Oil Corp., Atlas Life Bldg., Tulsa, Okla.....'26
Krueger, Max L., Union Oil Co. of Calif., 617 W. Seventh St., Los Angeles, Calif...'25
Krum, William M., Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex.....'38
Krumbein, William C., Dept. of Mechanical Eng., Univ. of California, Berkeley, Calif.....'39
Kugler, Hans G., Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B.W.I....'27
Kündig, Ernst, Pfäffikon, Zurich, Switzerland.....'38
Kurtz, Robert G., The Ohio Oil Co., Marshall, Ill.....'31
‖Kyle, Jerry R., Carter Oil Co., Box 801 Tulsa, Okla.....'39

La Croix, Morris F., Paine Webber & Co., 24 Federal St., Boston, Mass.....'21
Ladner, A. L., 3416 Palm, Houston, Tex.....'39
Lafferty, Robert C., Jr., Owens, Libbey-Owens, Gas Dept., Charleston, W. Va....'30
Lahee, Frederic H., Sun Oil Co., Box 2880, Dallas, Tex.....'19
Laiming, Boris G., The Texas Co., 929 S. Broadway, Los Angeles, Calif.....'28
‖Laird, Wilson M., State Geol. Survey, Univ. of N. Dakota, Grand Forks, N. Dak..'41
Lake, Charles L., Tide Water Assoc. Oil Co., Box 1404, Houston, Tex.....'28
Lake, James L., Subterrex, Box 2545, Houston, Tex. (Last address).....'39
Lalicker, Cecil Gordon, Dept. of Geology, Univ. of Oklahoma, Norman, Okla.....'37
Lamar, Lee C., Carter Oil Co., 215 Hersee Bldg., Mt. Pleasant, Mich.....'36
Lamb, R. C., 1208 Union Natl. Bank Bldg., Wichita, Kan.....'28
Lambert, Gerald S., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'28
Lamon, Robert S., Richmond Petr. Co., Edificio Clavijo, Bogota, Colombia, S. A...'38
Lancaster, L. Kenneth, Tide Water Assoc. Oil Co., Box 731, Tulsa, Okla.....'38
Landes, Kenneth K., Geol. Dept., Univ. of Michigan, Ann Arbor, Mich.....'38
Lane, Alfred C., 22 Arlington St., Cambridge, Mass.....'24
Lane, C. W., 1415 E. Thirty-fourth, Tulsa, Okla.....'29
Lane, Robert Cecil, independent, Lake Waco Dr., Waco, Tex.....'34
‖Lang, Ralph H., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa.....'37
Lang, W. B., U. S. Geol. Survey, Washington, D. C.....'25
Lang, William J., Carter Oil Co., Box 801, Tulsa, Okla.....'36
Lange, Robert William, Amerada Petr. Corp., 417 S. Hill St., Los Angeles, Calif...'38
‖Langford, David Kemp, 2812 Tenth St., Wichita Falls, Tex.....'42
Langham, N. T., Petroleum Development (Qatar) Ltd., via Manama, Bahrein Island, Persian Gulf.....'39
‖Langlois, Alice, Newmont Mining Corp., Rm. 1501, 14 Wall St., New York, N. Y..'41
Langton, Claude M., Houston Oil Co., Petroleum Bldg., Houston, Tex.....'35
LaPeire, George W., Box 361, Olney, Ill.....'26
‖Lapp, John H., independent, 706 Union Natl. Bank Bldg., Wichita, Kan.....'40
Larkin, J. J., Jr., 527 First Natl. Bank Bldg., Wichita, Kan.....'38
Larkin, Pierce, 1440 S. Norfolk, Tulsa, Okla.....'23
‖Larrabee, David M., Staso Milling Co., Poultney, Vt.....'37
Larsen, Raymond M., U. S. Geol. Survey, 305 Federal Bldg., Casper, Wyo.....'35
Larsh, N. B., Sinclair Prairie Oil Co., Midland, Tex.....'30
Larsh, Walter W., consulting, 1307 Union Natl. Bank Bldg., Wichita, Kan.....'25
Larson, Carl L., Jr., Stanolind Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan.....'37
LaRue, James E., Humble Oil & Refg. Co., Houston, Tex.....'20
LaRue, Wilton W., McCollum Expl. Co., 611 Esperson Bldg., Houston, Tex.....'35
Laskey, G. E., consulting, 710 N. Vienna St., Ruston, La.....'21
Lasky, Bernard H., 702 Mellie Esperson Bldg., Houston, Tex.....'19
‖Latimer, F. Hubert, Sun Oil Co., Crossville, Ill.....'39
La Touche, John D., Sun Oil Co., Box 2831, Beaumont, Tex.....'31
Laudon, Lowell R., Geol. Dept., Univ. of Kansas, Lawrence, Kan.....'42
Laughbaum, Graydon H., Sinclair Prairie Oil Co., 703 Colcord Bldg., Oklahoma City, Okla.....'31
Laughlin, R. W., Box 383, Oklahoma City, Okla.....'23
Laves, U. R., consulting, 723 S. Broadway, Ada, Okla.....'25
Lavington, Charles S., Continental Oil Co., Denver, Colo.....'24
*Lawson, Andrew C., Dept. of Geology, Univ. of California, Bacon Hall, Berkeley, Calif.....'27
Lawton, Joe, Reliance Oil & Royalty Corp., 1520 Alamo Natl. Bldg., San Antonio, Tex.....'27

Lay, Roy L., The Texas Co., Box 2332, Houston, Tex.....'33
Leach, Claude E., Tide Water Assoc. Oil Co., Box 811, Ventura, Calif.....'40
Leach, Thomas W., consulting, 706 Natl. Bank of Commerce Bldg., Tulsa, Okla...'25
Leatherock, Constance, Tide Water Assoc. Oil Co., Tulsa, Okla.....'29
Leavenworth, Paul B., Gulf Oil Corp., Box 2100, Houston, Tex.....'26
Lebkicher, Roy, Standard Oil Co., Rm. 1202, 225 Bush St., San Francisco, Calif...'27
LeConte, Joseph, Richfield Oil Corp., 560 Haberfelde Bldg., Bakersfield, Calif.....'38
‖Ledingham, Glen W., Western Gulf Oil Co., Box 1392, Bakersfield, Calif.....'40
Lee, Clarence L., The Texas Co. (Venezuela), Ltd., Apt. 267, Caracas, Venezuela, S. A.....'31
Lee, Harvey W., Union Oil Co. of Calif., 11th Floor Union Oil Bldg., Los Angeles, Calif.....'40
Lee, Herbert V., The Texas Co. (Venezuela), Ltd., Apt. 267, Caracas, Venezuela, S. A.....'38
Lee, John E., Jr., 1901 N. Louisa, Shawnee, Okla.....'42
Lee, Lynn K., Pure Oil Co., Fort Worth, Tex.....'28
Lee, Marvin, 809 Bitting Bldg., Wichita, Kan.....'17
Lee, Wallace, Kansas Geol. Survey, Lawrence, Kan.....'20
Lees, George M., Anglo Iranian Oil Co., Ltd., Britannic House, Finsbury Circus, London, E. C. 2, England.....'31
‖Leeper, Alan B., Honolulu Oil Corp., Midland, Tex.....'41
Lees, Laurence F., Phillips Petr. Co., Box 958, Ardmore, Okla.....'36
Lehman, Roy P., Phillips Petr. Co., Box 152, Shawnee, Okla.....'26
Lehner, Ernest J., Burmah Oil Co., Ltd., Khodaung, Upper Burma.....'29
Leibensperger, Raymond, 151 Highland Ave., Montclair, N. J.....'18
Leidhold, Clemens, Gaspar Campos 554, Vicente Lopez, F.C.C.A., Argentina, S. A..'30
Leighton, Morris M., Illinois Geol. Survey, 305 Ceramics Bldg., Urbana, Ill.....'24
Leiser, J. B., Expl. Dept., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'26
Leonard, Clarence Z., Box 942, Corpus Christi, Tex.....'35
Leonardon, E. G., Schlumberger Well Surveying Corp., Box 2175, Houston, Tex...'34
Lepper, G. W., c/o H. M. Petroleum Dept., 2 Dean Stanley St., Westminster, London, S. W. 7, England.....'25
‖LeRoy, Tom E., Dept. of Geology, Louisiana State Univ., Baton Rouge, La.....'41
Lester, John L., 350th Field Artillery, Camp Livingston, La.....'38
Lester, O. C., Jr., Geophysical Research Corp., Drawer 2040, Tulsa, Okla.....'29
Levorsen, A. I., consulting, 221 Woodward Blvd., Tulsa, Okla.....'19
‖Levy, David Jacob, 2217 Huldy St., Houston, Tex.....'40
‖Lewark, James E., Carter Oil Co., St. Elmo, Ill.....'41
Lewis, Frank E., Box 746, Midland, Tex.....'21
Lewis, James A., Core Laboratories, Inc., 708 Santa Fe Bldg., Dallas, Tex.....'38
Lewis, James O., consulting, 1912 Commerce Bldg., Houston, Tex.....'19
Lewis, J. Whitney, Dominican Seaboard Oil Co., Inc., Trujillo City, Dominican Republic.....'23
Lewis, Milton W., 4161 Farmdale Ave., Hollywood, Calif.....'37
Lewis, Ray C., Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'36
‖Lewis, William Dabney, Magnolia Petr. Co., Box 1828, Oklahoma City, Okla....'40
Ley, Henry A., 225 W. Elsmere, San Antonio, Tex.....'19
Leyds, Louis W., Asiatic Petr. Corp., 25 Van Stienhovenstraat, The Hague, Netherlands.....'27
Liddle, Ralph A., 520 N. Ross Ave., Mexia, Tex.....'20
Lieb, Victor E., 1317 Shell Bldg., Houston, Tex.....'24
Lilley, Ernest R., 41 Woodland Park Dr., Tenafly, N. J.....'28
‖Lillibridge, Fred S., Transwestern Oil Co., Wichita, Kan.....'41
Lillibridge, Harry E., 649 Dudley, Shreveport, La.....'28
Lilligren, J. M., Sinclair Prairie Oil Co., Box 443, Parkersburg, W. Va.....'21
‖Liming, John A., Rogers, Neb.....'40
Lincoln, W. W., c/o Lincoln Petr. Corp., Box 193, Lockhart, Tex.....'28
Lindberg, George D., Sun Oil Co., Toledo, Ohio.....'38
Lindeblad, E. E., Geol. Dept., Continental Oil Co., Midland, Tex.....'19
Lindner, Joseph Leicht, Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'41
Lindsay, Robert E., Tide Water Assoc. Oil Co., Bin H, Oildale, Calif.....'36
Lindsly, Ben E., Securities & Exchange Commission, 1424 K St., N. W., Washington, D. C.....'37

Link, Theodore A., Geol., Dept., Imperial Oil, Ltd., Calgary, Alta., Canada....'21
Link, Walter K., West Indian Oil Co., S. A., Box XXIII, San Jose, Costa Rica...'30
‖Little, Sterling E., Rm. 27, Bldg. 701, Naval Air Base, Jacksonville, Fla.....'39
Littlefield, Max S., Gulf Oil Corp., Box 661, Tulsa, Okla.....'31
Livingston, Noyes B., Box 989, Kingsville, Tex.....'26
Lloyd, Abe M., Sun Oil Co., Box 1215, Shreveport, La.....'21
Lloyd, E. Russell, consulting, Box 1026, Midland, Tex.....'21
Lock, John Henry, Sinclair Prairie Oil Co., Box 1710, Baton Rouge, La.....'38
Lockett, George L., Mene Grande Oil Co., C. A., Apt. 45, Barcelona, Venezuela, S. A.....'35
Lockett, J. R., Ohio Fuel Gas Co., 99 N. Front St., Columbus, Ohio.....'28
Lockwood, R. P., 705 Lancaster Bldg., Calgary, Alta., Canada.....'30
‖Loeblich, Helen Tappan, Dept. of Geology, Tulane Univ., New Orleans, La.....'38
‖Loeffler, Richard J., Standard Oil Co. of Venezuela, Caripito, Venezuela, S. A...'40
Loel, Wayne, consulting, 808 Subway Terminal Bldg., Los Angeles, Calif.....'22
Loetterle, Gerald John, Shell Oil Co., Inc., Box 2099, Houston, Tex.....'33
‖Lokman, Kemal, M. T. A., Institute, Petrol Grubu, Ankara, Turkey.....'31
Long, Carl T., Hillman-Long, Inc., 1052 Subway Terminal Bldg., Los Angeles, Calif.'25
Longmire, William R., Gulf Oil Corp., Box 106, Indianapolis, Ind.....'20
Longwell, Chester R., Dept. of Geology, Yale Univ., New Haven, Conn.....'27
Lonsdale, John T., Dept. of Geology, Iowa State College, Ames, Iowa.....'29
‖Loofbourow, J. S., Jr., 712 S. Citrus, Los Angeles, Calif.....'40
‖Loomis, Frederic B., Jr., Shell Oil Co., Inc., Box 573, Kosciusko, Miss.....'41
‖Loring, Ralph C., International Petr. Co., Ltd., Apt. 803, Guayaquil, Ecuador, S. A.....'37
Loskamp, Alvin P., Union Oil Co. of Calif., 1214 Petroleum Bldg., Midland, Tex...'25
‖Lott, Alfred Walker, Pan American Prod. Co., Mellie Esperson Bldg., Houston, Tex.....'41
Lott, Frederick S., Petr. Economics Div., U. S. Bur. of Mines, 202 Federal Bldg., Bartlesville, Okla.....'30
Louderback, George D., Dept. of Geology, Univ. of California, Bacon Hall, Berkeley, Calif.....'25
Loughlin, Gerald F., U. S. Geol. Survey, Washington, D. C.....'37
Lounsbery, D. E., Geol. Dept., Phillips Petr. Co., Bartlesville, Okla.....'21
Love, John David, Shell Oil Co., Inc., Box 476, Centralia, Ill.....'39
Love, Perry R., Magnolia Petr. Co., 721 Browder, Dallas, Tex.....'30
Lovejoy, J. B., Gulf Oil Corp., Box 1290, Fort Worth, Tex.....'27
Lovejoy, John M., Seaboard Oil Co. of Delaware, 39 Broadway, New York, N. Y.'24
Lovely, H. R., c/o Westminster Bank, Hounslow, Middlesex, England.....'40
Lovering, T. S., Dept. of Geology, Univ. of Michigan, Ann Arbor, Mich.....'31
Low, Julian W., Rt. 8, Box 628, Denver, Colo.....'40
Lowman, Shepard W., Shell Oil Co., Inc., 641 M & M Bldg., Houston, Tex.....'26
‖Lozo, Frank E., Jr., Dept. of Geology, Texas Christian Univ., Fort Worth, Tex...'39
Lucke, John B., Beach Hall, Univ. of Connecticut, Storrs, Conn.....'30
Lucky, M. C., producer, 1912 Albans, Houston, Tex.....'26
‖Lueth, Clinton A., W. C. McBride, Inc., 1904 Milam Bldg., San Antonio, Tex.....'41
Lugn, A. L., Univ. of Nebraska, Lincoln, Neb.....'31
Lukert, Louis H., The Texas Co., Box 2420, Tulsa, Okla.....'36
Luman, Edmondson D., Atlantic Refg. Co., Box 2819, Dallas, Tex.....'24
Lund, Gage V., The California Co., 1818 Canal Bldg., New Orleans, La.....'27
Lund, Wesley R., 1607 N. Boston Pl., Tulsa, Okla.....'40
‖Lupton, Benjamin C., General Petr. Corp., 6 Crites Bldg., Bakersfield, Calif.....'38
‖Lupton, John H., III, 109 Pitman, Pitman, N. J.....'40
‖Lyle, William E., Jr., 1611 Ninth St., Lubbock, Tex.....'40
Lynch, S. A., Dept. of Geology, North Texas Agricultural College, Arlington, Tex..'34
Lynn, Robert H., A. & K. Petr. Co., 2009 First Natl. Bank Bldg., Oklahoma City, Okla.....'21
Lynton, Edward D., Standard Oil Co. of Calif., Drawer 430, Whittier, Calif.....'23
Lyons, Paul L., Carter Oil Co., Box 801, Tulsa, Okla.....'36
Lyons, Richard T., Tide Water Assoc. Oil Co., Box 1404, Houston, Tex.....'22
Lytel, Harvey M., Socony-Vacuum Oil Co., 62 Sharia Ibrahim Pasha, Cairo, Egypt.'28
Lytle, J. Edward, 540 Stephenson Ave., Shreveport, La.....'31

MacDonald, Erwin H., 4161 Vantage Ave., Studio City, Calif.....'23
MacDonell, James A., producer, 805 State St., Lima, Ohio.....'25
Mackay, Donald K., consulting, 18th Floor, Mellie Esperson Bldg., Houston, Tex..'25
MacKay, Hugh, 216 S. Oak St., Sapulpa, Okla.....'17
Mackenzie, Andrew N., Cia de Petroleo Ganso Azul, Edificio Hidalgo, Plaza San Martin, Lima, Peru, S. A.....'22
‖Mackenzie, W. D. C., Royalite Oil Co., Ltd., Turner Valley, Alta., Canada.....'37
MacNaughton, Lewis W., DeGolyer, MacNaughton & McGhee, 1000 Continental Bldg., Dallas, Tex.....'26
MacNeil, Donald J., Expl. Dept., McColl-Frontenac Oil Co., 707 Lancaster Bldg., Calgary, Alta., Canada.....'38
Macready, George A., Macready Orientation Core Service, 3678 Main St., Los Angeles, Calif.....'19
‖Madden, Lloyd W., General Delivery, Albany, Tex.....'41
Maddox, Gerald C., Carter Oil Co., Box 150, Magnolia, Ark.....'29
Maddox, Walter H., Caltex (Australia) Oil Development Pty., Ltd., Box 1593-BB, G.P.O., Sydney, Australia.....'31
‖Madera, R. F., Shell Oil Co., Box 2099, Houston, Tex.....'39
Maebius, Jed B., Gulf Refg. Co., Box 811, Saginaw, Mich.....'38
Magale, John F., Box 73, Shreveport, La.....'38
Maher, John C., Box 8315, Univ. Station, Baton Rouge, La.....'36
Mahoney, J. F., consulting, 1019 Ninth St., Lake Charles, La.....'36
‖Mahoney, Roger S., Mene Grande Oil Co., Apt. 45, Barcelona, Anzoategui, Venezuela, S. A.....'37
Malamphy, Mark C., 414 Goethe St., Cumberland, Md.....'30
Maley, Vaughn C., Humble Oil & Refg. Co., Box 1600, Midland, Tex.....'28
Maley, W. A., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex.....'29
‖Malkin, Doris S., Fohs Oil Co., Esperson Bldg., Houston, Tex.....'37
Mallory, R. W., Stanolind Oil & Gas Co., Box 40, Casper, Wyo.....'40
Manes, O. B., Stanolind Oil & Gas Co., Box 135, Natchitoches, La.....'38
Manger, G. Edward, Mene Grande Oil Co., Apt. 45, Barcelona, Venezuela, S. A...'37
Manion, Clarence E., Manion Placer Mines, 1776 Krameria St., Denver, Colo.....'27
‖Mankin, Warren W., 1408 Polk, Wichita Falls, Tex.....'41
Manlove, Charles Francis, Union Oil Co. of Calif., Orcutt, Calif.....'39
‖Mann, Robert S., Shell Oil Co., Expl. Dept., Box 1509, Midland, Tex.....'40
‖Manthos, Atlee G., 521 McLeary St., San Antonio, Tex.....'38
‖Maples, Steve C., 1120 S. Florence Pl., Tulsa, Okla.....'41
Markham, Edmond O., Carter Oil Co., Box 801, Tulsa, Okla.....'20
Markley, Elmer A., Barnsdall Oil Co., Tulsa, Okla.....'23
Markley, Joseph H., The Texas Co., Box 1720, Fort Worth, Tex.....'28
‖Marks, Jay Glenn, International Petr. Co., Casilla 803, Guayaquil, Ecuador, S. A..'42
Marr, John D., Seismic Explorations, Inc., Houston, Tex.....'29
Marshall, F. E., Snowden & McSweeney Co., 1108 Sinclair Bldg., Fort Worth, Tex..'36
‖Marshall, J. W., Pure Oil Co., Box 271, Tulsa, Okla.....'42
Marshall, John, The Texas Co., Box 539, Ardmore, Okla.....'38
Marshall, Lester R., Continental Oil Co., Box 632, Shreveport, La.....'39
‖Marshall, W. H., Union Prod. Co., Box 1407, Shreveport, La.....'40
Martin, B. G., Office of Petr. Coordinator, 245 Mellie Esperson Bldg., Houston, Tex.....'30
‖Martin, Benjamin H., 2510 Kingston Dr., Houston, Tex.....'41
Martin, Bethea A., Standard Oil Co. of Venezuela, Caripito, Venezuela, S. A.....'41
Martin, Edgar E., Sun Oil Co., McAllen, Tex.....'41
Martin, Francis I., Socony-Vacuum Oil Co., Apt. 1193, Caracas, Venezuela, S. A...'23
Martin, George C., Dept. of the Interior, U. S. Board on Geographical Names, Washington, D. C.....'24
Martin, Helen M., Dept. of Conservation, Michigan Geol. Survey, State Office Bldg., Lansing, Mich.....'25
‖Martin, James L., Jr., Louisiana Geol. Survey, Baton Rouge, La.....'40
Martin, Lois T., 772 Santa Ynez St., Stanford University, Calif.....'41
Martin, P. M., Continental Oil Co., Box 1800, Wichita, Falls, Tex.....'29
Martin, Rodolfo, Y. P. F., Avda. Roque Saenz Pena 777, Buenos Aires, Argentina, S. A.....'42

Martin, Rudolf, Caribbean Petr. Co., Maracaibo, Venezuela, S. A.....'40
Martyn, Phil F., Houston Oil Co. of Texas, Box 2412, Houston, Tex.....'28
Marvin, Gaurd S., consulting, 908 N. W. Sixteenth St., Oklahoma City, Okla.....'37
Mason, John F., Dept. of Earth Sciences, Univ. of Pennsylvania, Philadelphia, Pa..'37
Mason, Shirley L., Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'19
Masterson, Reba B., 403 W. Park, San Antonio, Tex.....'23
‖Matheny, H. Claire, Morrill, Neb.....'27
Mather, Kirtley, Harvard University, Geol. Museum, Cambridge, Mass.....'21
Mathes, Donald E., 756th Tank Bn. (L) Fort Lewis, Wash.....'23
Mathews, John W., Western Geophysical Co., Bakersfield, Calif.....'39
Mathieu, J. L., Schlumberger Well Surveying Corp., Houston, Tex.....'41
Matjasic, Wallace L., Honolulu Oil Corp., Bakersfield, Calif.....'40
Matson, Martin, Cities Service Oil Co., 907 Milam Bldg., San Antonio, Tex.....'25
‖Matson, Thomas E., Kingwood Oil Co., Box 67, McLeansboro, Ill.....'40
‖Matthews, Charles L., 817 N. A St., Wellington, Kan.....'38
‖Matthews, Edwin P., 817 N. A St., Wellington, Kan.....'40
Maucini, Joseph J., Superior Oil Co., Wichita Falls, Tex.....'27
Mauck, Melvin Dwight, Pure Oil Co., Box 271, Tulsa, Okla.....'39
Maverick, Phillip, Securities & Exchange Commission, Rm. 103, U. S. Courthouse, Fort Worth, Tex.....'23
Maxson, John H., 650 Subway Terminal Bldg., Los Angeles, Calif.....'34
‖Maxwell, Curtis, F., Humble Oil & Refg. Co., Box 127, Overton, Tex.....'40
‖Maxwell, John Crawford, Dept. of Geology, Princeton Univ., Princeton, N. J.....'39
Maxwell, Riley G., consulting, 418 Mims Bldg., Abilene, Tex.....'30
Maxwell, Ross A., National Park Service, Region III Headquarters, Santa Fe, N. Mex.....'30
May, Art R., Superior Oil Co., Bakersfield, Calif.....'21
May, George N., Union Sulphur Co., Inc., Sulphur, La.....'37
May, John C., Tide Water Assoc. Oil Co., Rt. 1, Box 197-X, Bakersfield, Calif.....'33
Mayfield, Gid C., c/o Fikes & Murchison, Dallas, Tex.....'38
Mayfield, W. I., Petty Geophysical Co., Box 2061, San Antonio, Tex.....'41
Mayfield, William W., Hope Nat. Gas Co., Box 1951, Clarksburg, W. Va.....'38
‖Mayhew, Eldon Jay, Box 161, Moab, Utah.....'41
McArthur, Donald, Texas Petr. Co., Apt. 877, Bogota, Colombia, S. A.....'20
McAuliffe, G. C., Southern Carbon Co., Drawer 1562, Monroe, La.....'32
McBee, William Dalton, Carter Oil Co., Jena, La.....'38
McCabe, William S., Superior Oil Co., 807 First Natl. Bank Bldg., Denver, Colo.....'38
McCallum, Henry D., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex.....'31
‖McCammon, John H., II, Box 1913, Univ. Station, Austin, Tex.....'39
McCampbell, John C., Dept. of Geology, Univ. of N. Carolina, Chapel Hill, N. C..'36
‖McCampbell, William G., Jr., Humble Oil & Refg. Co., Box 1512, Mobile, Ala...'42
McCanne, Rolland W., The Ohio Oil Co., Casper, Wyo.....'35
McCarter, W. Blair, consulting, 1415 Sul Ross, Houston, Tex.....'27
‖McCarver, A. G., Baroid Well Logging Service, 1113 Second Natl. Bank Bldg., Houston, Tex.....'41
‖McCarver, Holland C., N.P.P.M., Paleisweg 33–35, Medan, Sumatra, N.E.I.....'41
McClain, Alan H., Geol. Dept., United Fuel Gas Co., Box 1256, Charleston, W. Va..'32
McClellan, Hugh W., 408 N. Fountain, Wichita, Kan.....'27
McCloskey, Downs, Amerada Petr. Corp., 417 S. Hill St., Los Angeles, Calif.....'33
McCloy, Walter L., Jr., Standard Oil Co., 1766 Midland Bldg., Cleveland, Ohio...'40
‖McClure, Harold Y., Gulf Oil Corp., Fort Worth, Tex.....'38
McClure, Perry S., R.R. 1, Elizabethtown, Ky.....'36
McCobb, Harry W., Nederlandsche Koloniale Petr. Mij., Songei Gerong, Palembang, Sumatra, N.E.I.....'28
McCollom, C. R., consulting, 504 Richfield Bldg., 555 S. Flower St., Los Angeles, Calif.....'23
McCollough, Edward H., Amerada Petr. Corp., 417 S. Hill St., Los Angeles, Calif..'24
McCollum, Leonard F., Carter Oil Co., Box 801, Tulsa, Okla.....'27
McCourt, James H., Glacier Prod. Co., Cut Bank, Mont.....'33
McCoy, Alex W., Deep Rock Oil Corp., Atlas Life Bldg., Tulsa, Okla.....'17
‖McCoy, Alex W., III, Carter Oil Co., Box 15, Bowling Green, Ky.....'41
McCoy, George Y., Republic Natl. Bank of Dallas, Dallas, Tex.....'37
McCoy, Joseph H., 1209 Lawnview, Jackson, Miss.....'37
McCrary, E. W., Box 861, Tulsa, Okla.....'18

McCready, Harry J., 4923 Knox Court, Denver, Colo.....'38
‖McCulloch, James Cole, Carter Oil Co., St. Elmo, Ill.....'40
McCulloch, Joseph P., The Texas Co., 135 E. Forty-second St., New York, N. Y..'26
McCullough, A. S., consulting, Clifton, Greene County, Ohio.....'17
McCullough, E. A., The Texas Co., c/o T. F. Roche, Apt. Nac. 323, Barranquilla, Colombia, S. A.....'41
McCullough, R. L., Cities Service Oil Co., Box 306, Great Bend, Kan.....'25
McCune, Paul, c/o McCune & Michaels, Burk Burnett Bldg., Fort Worth, Tex...'28
‖McDaniel, Fred, I. T. I. O. Co., Box 195, Great Bend, Kan.....'39
McDermott, Eugene, Geophysical Service, Inc., 1311 Republic Bank Bldg., Dallas, Tex.....'29
McDonald, Worth W., 2154 W. Kings Highway, San Antonio, Tex.....'24
McDonnold, H. W., The Texas Co., Box 2332, Houston, Tex.....'36
McEachin, W. D., Sinclair Wyoming Oil Co., Box 808, Evansville, Ind.....'38
‖McFadden, William A., Jr., Standard Oil Co. of Texas, Box 1249, Houston, Tex..'38
McFarlan, Arthur C., Univ. of Kentucky, Lexington, Ky.....'38
McFarland, Earl R., 200 N. E. Thirteenth St., Oklahoma City, Okla.....'30
McFarland, L. R., Magnolia Petr. Co., Box 1406, Shreveport, La.....'33
McFarland, Paul W., Sun Oil Co., Box 2880, Dallas, Tex.....'23
McFarland, R. S., Seaboard Oil Co., 1400 Continental Bldg., Dallas, Tex.....'18
McFerron, George I., Adams Oil & Gas Co., 840 Mellie Esperson Bldg., Houston, Tex.....'22
†McGaha, Charles P., Fain-McGaha Oil Corp., 607 Hamilton Bldg., Wichita Falls, Tex.....'29
McGee, D. A., Kerlyn Oil Co., First Natl. Bank Bldg., Oklahoma City, Okla.....'29
McGhee, J. Rex, Shell Oil Co., Inc., Box 476, Centralia, Ill.....'30
McGhee, George C., Office of Prod. Management, Rm. 4072, Social Security Bldg., Washington, D. C.....'31
McGill, William M., Virginia Geol. Survey, Box 1428, Univ. Station, Charlottesville, Va.....'26
McGirl, J. N., consulting, 910 S. Boston, Tulsa, Okla.....'25
McGlasson, H. E., Stanolind Oil & Gas Co., 215 Weber Bldg., Lake Charles, La...'37
McGlothlin, Tom, Gulf Refg. Co., Box 1105, Jackson, Miss.....'29
McGlothlin, William C., consulting, 2121 W. Fourth Ave., Corsicana, Tex.....'31
‖McGovney, Paul E., Honolulu Oil Corp., 410 Professional Bldg., Bakersfield, Calif.'39
McGowan, F. H., Humble Oil & Refg. Co., Houston, Tex.....'29
McGuigan, F. H., Box 1742, Midland, Tex.....'38
McGuirt, James H., Louisiana State Univ., Geol. Dept., Baton Rouge, La.....'36
‖McHugh, James W., The Texas Co., Box 476, Mattoon, Ill.....'40
‖McHugh, W. E., Phillips Petr. Co., 610 Ellis-Singleton Bldg., Wichita, Kan.....'35
McIntyre, George T., I. T. I. O. Co., Box 4577, Capitol Hill Station, Oklahoma City, Okla.....'30
McIntyre, Paul J., 703 Natl. Bank of Commerce Bldg., Tulsa, Okla.....'19
McKanna, Edwin A., consulting, 801 Columbia St., S. Pasadena, Calif.....'21
McKay, A. E., Atlantic Refg. Co., Box 871, Midland, Tex.....'30
McKee, Edwin D., Museum of Northern Arizona, Flagstaff, Ariz.....'41
McKee, H. Harper, c/o Brokaw, Dixon & McKee, 120 Broadway, New York, N. Y..'17
‖McKinsey, M. H., Shell Oil Co., Inc., Box 1509, Midland, Tex.....'40
McKnight, C. R., Arkansas Nat. Gas Co., Box 1734, Shreveport, La.....'25
McLaren, Robert L., Arkansas Louisiana Gas Co., Shreveport, La.....'27
McLellan, Hiram J., Humble Oil & Refg. Co., Box 2180, Houston, Tex.....'20
‖McLendon, Dan Harvey, 94th C. A. (A.A.), Langley Field, Va.....'41
McLeod, Angus, consulting, Apt. 412, Maple Terrace, Dallas, Tex.....'19
McMillan, John R., Barnsdall Oil Co., Petroleum Securities Bldg., Los Angeles, Calif.....'38
McMillan, Joseph M., Adams Louisiana Co., 2302 Experson Bldg., Houston, Tex...'27
‖McMillan, Robert, Shell Oil Co., Inc., 2000 Alamo Natl. Bldg., San Antonio, Tex..'42
McMillen, Raymond F., Coralena Oil Co., 929 Kennedy Bldg., Tulsa, Okla.....'27
‖McMorris, William Albert, Jr., Carter Oil Co., Box 801, Tulsa, Okla.....'41
‖McMurtry, Wilbur Earl, 538 S. Quentin, Wichita, Kan.....'41
McNab, James, B. O. Q., France Field, Canal Zone.....'37
McNaughton, D. A., Texas Petr. Co., c/o T. F. Roche, Barranquilla, Colombia, S.A.....'41
‖McNeal, Robert P., Seaboard Oil Co., Evansville, Ind.....'41

McNeely, Robert B., consulting, 209 Ellis-Singleton Bldg., Wichita, Kan.....'25
McNeil, Harold E., Derby Oil Co., Wichita, Kan.....'39
‖McNutt, G. R., G. B. #105, Dept. of Geology, Univ. of Texas, Austin, Tex.....'42
McQueen, Henry S., Missouri Geol. Survey, Rolla, Mo.....'33
‖McReynolds, Gregg F., Box 99, Palestine, Tex.....'36
McWhirt, Burr, Income Tax Unit, Rm. 3232, Internal Revenue Bldg., Washington, D. C.....'18
Mead, Roy G., 4321 Clinton St., Los Angeles, Calif.....'31
‖Mead, Roy G., Jr., Mohawk Petr. Corp., Box 1476, Bakersfield, Calif.....'39
‖Meagher, D. Pope, Carter Oil Co., Drawer 1490, Jackson, Miss.....'41
Mebane, Robert Duff, 916 Milam Bldg., San Antonio, Tex.....'38
Mehl, M. G., Dept. of Geology, Univ. of Missouri, Columbia, Mo.....'17
Melchior, Louis F., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa.....'37
Mellen, Frederic F., consulting, Rt. 5, Jackson, Iuka, Miss.....'40
Mellen, William P., The California Co., Denver, Colo.....'31
‖Melsheimer, Albert H., Union Sulphur Co., Inc., Sulphur, La.....'41
Melton, Frank A., Dept. of Geology, Univ. of Oklahoma, Norman, Okla.....'42
Meltzer, Lee Hillard, 431 Slattery Blvd., Shreveport, La.....'37
‖Melville, A. G., consulting, 1114 Second St., Manhattan Beach, Calif.....'38
‖Melvin, Marlowe D., Carter Oil Co., Eldorado, Ill.....'39
‖Melzer, Laurence S., Stanolind Oil & Gas Co., Box 905, Wichita Falls, Tex.....'41
Mendelsohn, Clive A., Anglo-Portuguese Oil Co., Ltd., Lisbon, Portugal.....'31
*Mendenhall, Walter C., U. S. Geol. Survey, Washington, D. C.....'22
Menefee, James C., 721 Browder St., Dallas, Tex.....'36
Menger, Hubert Emil, Stanolind Oil & Gas Co., 1132 Milam Bldg., San Antonio, Tex.....'36
Menken, Fred A., Associated Div., Tide Water Assoc. Oil Co., San Francisco, Calif..'32
Meredith, Carlton, consulting, Kirby Bldg., Dallas, Tex.....'20
‖Merrill, William R., Tide Water Assoc. Oil Co., Box 811, Ventura, Calif.....'42
Merritt, Floyd C., 1567 Charlton Rd., San Marino, Calif.....'23
Merritt, John W., 321 S. Detroit, Tulsa, Okla.....'18
Merritt, Roy W., 50 W. Fiftieth St., Eighth Floor, New York, N. Y.....'29
Merry, Edward T., c/o Merry Bros. & Perini, Inc., Abilene, Tex.....'25
Messman, Roger L., 212 W. Eleventh St., Hays, Kan.....'41
Meszaros, W. A., M. G. O. Seismograph, Apt. 45, Barcelona, Venezuela, S. A.....'42
Metcalf, Myron C., Box 637, Homer, La.....'30
Mettner, Francis E., The Texas Co., Box 1801, Wichita, Kan.....'38
Metts, Dean F., Humble Oil & Refg. Co., 1405 Canal Bldg., New Orleans, La.....'34
Metzner, Loyde H., Signal Oil & Gas Co., 811 W. Seventh St., Los Angeles, Calif.'41
Meyer, Arthur M., Atlantic Oil Refg. Co., Box 169, Shawnee, Okla.....'21
‖Meyer, Robert F., Darby Petr. Corp., 802 Ellis Singleton Bldg., Wichita, Kan...'39
Meyer, Willis G., DeGolyer, MacNaughton & McGhee, 1000 Continental Bldg., Dallas, Tex.....'37
Meyers, P. A., Pan American Prod. Co., 1235 Mellie Esperson Bldg., Houston, Tex..'25
‖Michael, James F., Amerada Petr. Corp., Box 2151, Jackson, Miss.....'38
‖Michaelson, Louis H., Gulf Oil Corp., Wichita, Kan.....'41
Michaux, Frank W., 1602 Commerce Bldg., Houston, Tex.....'31
Michelin, James, consulting, Rm. 507, 621 S. Spring St., Los Angeles, Calif.....'35
Milek, Andrew, 12 E. Twenty-first St., Tulsa, Okla.....'22
‖Miles, Phil M., 808 S. St. Asaph St., Alexandria, Va.....'41
Millard, William J., 4224 Hastings St., El Paso, Tex.....'17
Miller, Albert Douglas, independent, 10 Levy Bldg., Lafayette, La.....'30
Miller, Arthur K., Univ. of Iowa, Iowa City, Iowa.....'39
Miller, B. Maxwell, The Texas Co., Box 2420, Tulsa, Okla.....'36
Miller, Carroll C., 3448 Aransas St., Corpus Christi, Tex.....'25
Miller, Charles P., Drawer I, Hobbs, N. Mex.....'35
Miller, David B., consulting, 1336 Gaylord St., Denver, Colo.....'29
Miller, David M., Union Prod. Co., Box 711, Beeville, Tex.....'37
Miller, E. Floyd, Oliphant Oil Corp., 911 Commercial Natl. Bank Bldg., Shreveport, La.....'24
Miller, Forrest J., Arkansas Fuel Oil Co., Box 283, Houston, Tex.....'22
Miller, Guy E., Shell Oil Co., Inc., Box 999, Bakersfield, Calif.....'25
Miller, J. Charles, 3715 Yuma St., N. W., Washington, D. C.....'19

‖Miller, John B., Richmond Petr. Co. of Colombia, Apt. Nac. 2760, Bogota, Colombia, S. A.....'41
Miller, John C., The Texas Co., Box 2332, Houston, Tex.....'28
Miller, Lloyd E., Sun Oil Co., Box 2880, Dallas, Tex.....'41
Miller, Milward, Humble Oil & Refg. Co., Midland, Tex.....'33
Miller, Powell W., Western Gas Co., Box 1036, Jal, N. Mex.....'40
Miller, Robert H., Western Gulf Oil Co., Bakersfield, Calif.....'37
Miller, Robert P., Richmond Petr. Co. of Colombia, Apt. Nac. 2760, Bogota, Colombia, S. A.....'28
Miller, Vincent, Geol. Dept., Phillips Petr. Co., Bartlesville, Okla.....'39
Miller, Wendell Z., 104 E. Twenty-sixth Pl., Tulsa, Okla.....'21
Miller, Willard L., Ramsey Petr. Corp., Oklahoma City, Okla.....'19
Miller, William Dana, Rm. 2704, 120 Broadway, New York, N. Y.....'31
Millikan, C. V., Amerada Petr. Corp., Drawer 2040, Tulsa, Okla.....'20
Millison, Clark, consulting, Beacon Bldg., Tulsa, Okla.....'27
Mills, Coe S., The Ohio Oil Co., Box 253, Lafayette, La.....'27
‖Mills, Lloyd C., Pure Oil Co., Box 671, Midland, Tex.....'39
Mills, R. van A., Continental Oil Co., Ponca City, Okla.....'21
Milner, Charles A., Jr., National Park Service, Box 325, Ardmore, Okla.....'25
Milner, Henry Brewer, Geochemical Laboratories, 92 Victoria St., Westminster, London, S. W. 1, England.....'31
Milstein, M., 155 McPherson Ave., Toronto, Ont., Canada.....'28
Milton, W. B., Jr., Gulf Oil Corp., Box 1200, Houston, Tex.....'38
Minkofsky, Anna, c/o Mrs. A. Page, 75 E. One Hundred Sixty-fifth St., New York, N. Y.....'39
Minor, H. E., Gulf Oil Corp., Houston, Tex.....'18
Minshall, Francis E., Continental Oil Co., 601 W. Fifth St., Los Angeles, Calif.....'37
Minton, Joseph W., Sun Oil Co., McAllen, Tex.....'36
‖Minton, Robert J., North LaBarge Oil Co., Box 46, LaBarge, Wyo.....'41
Mintrop, L., Breslau University, Schlossblatz 2, Essen-Werden, Germany.....'31
Miser, Hugh D., U. S. Geol. Survey, Washington, D. C.....'23
Mitchell, George D., Jr., The Texas Co., Box 2332, Houston, Tex.....'34
Mitchell, Harold D., 1935 Richmond Rd., Houston, Tex.....'38
Mitchell, James G., Pure Oil Co., Box 311, Olney, Ill.....'41
Mitchell, Mark W., consulting, Box 326, Lytle, Tex.....'41
Mitchell, Robert B., Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'29
Mix, C. A., 1001 W. Storey St., Midland, Tex.....'26
Mix, Sidney E., consulting, 902 Unadilla St., Shreveport, La.....'22
‖Mohler, C. Edwin, Carter Oil Co., Mattoon, Ill.....'39
Mohler, Donald P., Humble Oil & Refg. Co., 538 Amarillo Bldg., Amarillo, Tex.....'39
Mohr, C. L., Ambassador Oil Corp., 1912 Fort Worth Natl. Bank Bldg., Fort Worth, Tex.....'25
Moir, John, c/o J. C. Jackson, Eagle, Chambers County, Tex.....'26
‖Monahan, Charles Joseph, U. S. Engineer Office, Geology Subsection, Little Rock, Ark.....'40
Monahan, Foster M., Sinclair Prairie Oil Co., Box 521, Tulsa, Okla.....'42
Moncrief, E. C., c/o Lauck & Moncrief, 520 Fourth Natl. Bank Bldg., Wichita, Kan.'23
Monk, John C., Sun Oil Co., Box 1149, McAllen, Tex.....'39
Monnett, V. E., Univ. of Oklahoma, Norman, Okla.....'19
Monroe, Watson H., U. S. Geol. Survey, Washington, D. C.....'31
‖Monsour, Edward, Louisiana State Univ., Baton Rouge, La.....'41
Monsour, Eli T., 1769 Lakeshore Dr., Shreveport, La.....'30
Monsour, Emil, Air Corps Replacement Center, Maxwell Field, Ala.....'36
Montgomery, A. J., Phillips Petr. Co., 1211 First Natl. Bank Bldg., Oklahoma City, Okla.....'29
Montgomery, C. Hall, Continental Oil Co., Box 1758, Bakersfield, Calif.....'37
Montgomery, Don D., consulting, Box 295, El Dorado, Ark.....'38
Montgomery, James C., Harrison Oil Co., Gulf Bldg., Houston, Tex.....'37
Montgomery, James G., United Nat. Gas Co., 308 Seneca St., Oil City, Pa.....'26
Montgomery, Phil C., Halliburton Oil Well Cementing Co., Durant, Okla.....'31
Moody, Clarence L., The Ohio Oil Co., Ricou-Brewster Bldg., Shreveport, La.....'20
Moody, Graham B., 35 Stonewall Rd., Berkeley, Calif.....'27
‖Moody, John D., 655 Oneonta, Shreveport, La.....'40

Moody, Ray R., Gulf Oil Corp., Wichita, Kan.....'27
Moore, B. W., 2005 S. Robertson, Tyler, Tex.....'31
Moore, Bernard N., 619 Wildrose Ave., Monrovia, Calif.....'41
‖Moore, Carl Allphin, Standard Oil Co. of New Jersey, Rm. 2130, 30 Rockefeller Plaza, New York, N. Y.....'39
Moore, Fred H., Geol. Dept., Magnolia Petr. Co., Box 239, Wichita Falls, Tex....'37
Moore, Homer C., The Texas Co., Box 2332, Houston, Tex.....'40
Moore, John I., c/o Moore Bros. Corp., Box 753, Midland, Tex.....'26
Moore, Kenneth B., 1748 S. Wheeling, Tulsa, Okla.....'29
‖Moore, Lee Wayne, Stanolind Oil & Gas Co., Box 1540, Midland, Tex.....'41
‖Moore, Marion J., Transwestern Oil Co., 1600 Milam Bldg., San Antonio, Tex.....'39
Moore, Prentiss D., c/o Moore Bros. Corp., Box 753, Midland, Tex.....'26
Moore, Raymond C., Univ. of Kansas, Lawrence, Kan.....'17
Moore, William B., Atlantic Refg. Co., Box 1346, Houston, Tex.....'34
‖Moorhead, Johnny, Continental Oil Co., Box 1800, Wichita Falls, Tex.....'41
Moran, Robert B., 215 W. Seventh St., Rm. 1035, Los Angeles, Calif.....'19
‖Moran, Robert B., Jr., Rt. 1, Box 234-X, Fresno, Calif.....'40
Moreman, Walter L., Magnolia Petr. Co., Box 1828, Oklahoma City, Okla.....'30
Morero, Joseph E., Skelly Oil Co., Box 1650, Tulsa, Okla.....'23
Moresi, Cyril K., consulting, 617 Carondelet Bldg., New Orleans, La.....'35
‖Morgan, Aubrey A., Athens, Tex.....'40
Morgan, Cecil L., 351 Edwards Hotel, Jackson, Miss.....'29
Morgan, Charles Gill, Apt. 196, Arlington Village, Arlington, Va.....'31
Morgan, D. E., New Zealand Oil Exploration, Ltd., Box 1663, Wellington, N. Z....'28
Morgan, D. M., Box 1111, Ponca City, Okla.....'25
Morgan, Frank A., Richfield Oil Corp., 555 S. Flower St., Los Angeles, Calif.....'24
Morgan, George D., Cardinal Oil Co., Box 1030, San Angelo, Tex.....'22
Morgan, Henry J., Jr., Atlantic Refg. Co., Box 2819, Dallas, Tex.....'28
Morgan, L. C., Morgan Acid, Inc., 505 Ellis-Singleton Bldg., Wichita, Kan.....'30
Morgan, L. G., Cities Service Oil Co., Mattoon, Ill.....'30
‖Morgan, Ray E., Wisconsin Inst. of Technology, Platteville, Wis.....'37
‖Morgan, Robert Edward, Atlantic Refg. Co., Box 808, Carlsbad, N. Mex.....'37
Morley, Harold T., Stanolind Oil Co., Box 591, Tulsa, Okla.....'19
Mornhinveg, A. R., 1822 Sul Ross 1, Houston, Tex.....'36
‖Morrill, Junius Houghes, Geol. Dept., Carter Oil Co., Wichita, Kan.....'42
Morris, A. Ferd, 1440 Esperson Bldg., Houston, Tex.....'21
‖Morris, James L., Pure Oil Co., Box 2107, Fort Worth, Tex.....'39
Morris, Lawrence K., United Geophysical Co., 1255 E. Green St., Pasadena, Calif..'39
Morris, Louis H., The Texas Co., Box 2332, Houston, Tex.....'38
Morris, Walter W., Eagle-Picher Mining & Smelting Co., Oil & Gas Dept., Henryetta, Okla.....'24
‖Morrison, T. E., Humble Oil & Refg. Co., Box 2180, Houston, Tex.....'27
Morrow, A. L., Magnolia Petr. Co., Box 872, Lake Charles, La.....'37
Morse, Roy R., Shell Oil Co., Inc., Shell Bldg., Houston, Tex.....'24
Morse, W. C., Dept. of Geology, Univ. of Mississippi, University, Miss.....'21
‖Mort, Frank P., Shell Oil Co., Inc., Box 204, Graham, Tex.....'41
Mortlock, Frank O., Industrial Dept., U. S. Navy Yard, Cavite, P. I.....'37
Mosburg, Lewis G., Stanolind Oil & Gas Co., Philcade Bldg., Tulsa, Okla.....'26
Moses, Carl E., Turner Petr. Co., Box 150, Mt. Pleasant, Mich.....'38
Moses, Harold F., Carter Oil Co., Box 801, Tulsa, Okla.....'29
Moss, Frank A., 28 Ridge St., South Perth, W. Australia.....'29
Moss, Rycroft G., Phillips Petr. Co., Bartlesville, Okla.....'34
Mossman, R. W., Seismograph Service Corp., 709 Kennedy Bldg., Tulsa, Okla...'36
Mossom, Stuart, Magnolia Petr. Co., 1704 Alamo Natl. Bldg., San Antonio, Tex...'29
‖Mott, William Dick, Island Expl. Co., Port Moresby, Papua.....'39
Moulton, Gail F., 1520 State St., Lawrenceville, Ill.....'23
Mountjoy, Joseph B., Amerada Petr. Corp., Atlanta, Ill.....'40
Mower, Lowell K., Geophysical Section, Shell Oil Co., Inc., Box 2099, Houston, Tex.'25
‖Mowrer, Loren E., Box 242, Eufaula, Okla.....'38
Moxey, Walter G., Stanolind Oil & Gas Co., Midland, Tex.....'36
Mueller, Frederick W., Skelly Oil Co., 1305 Esperson Bldg., Houston, Tex.....'33
Muilenburg, Garrett A., Missouri School of Mines, Rolla, Mo.....'41
Muir, J. Lawrence, Amerada Petr. Corp., Box 896, Shawnee, Okla.....'30

Mulholland, Malcolm M., Tropical Oil Co., Barranca-Bermeja, Colombia, S. A....'40
‖Mull, J. A., Jr., Republic Nat. Gas Co., 711 Fourth Natl. Bank Bldg., Wichita, Kan.....'41
Müllerried, F. K. G., Av. Mazatlan 208, Tacubaya, D. F., Mex.....'24
‖Mundorf, T. Dean, Gulf Refg. Co., Box 262, Vincennes, Ind.....'37
Munoz, Robert R., Terrace Oil Co., Inc., 42 Broadway, New York, N. Y.....'30
‖Munro, James H., Phillips Petr. Co., Box 202, Baker, Mont.....'39
Munroe, Donald J., Sun Oil Co., Box 566, Hattiesburg, Miss.....'28
Munyan, Arthur C., Dept. of Geology, Emory University, Ga.....'32
Murchison, Eugene A., Humble Oil & Refg. Co., Box 1512, Mobile, Ala.....'30
‖Murdoch, Ernest J., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'42
‖Murphy, Boyd F., Amerada Petr. Corp., Box 2062, Tyler, Tex.....'38
Murphy, James K., British-American Oil Prod. Co., Philtower Bldg., Tulsa, Okla..'28
Murphy, P. C., Prod. Dept., Phillips Petr. Co., Bartlesville Okla.....'25
Murray, A. N., Dept. of Geology, University of Tulsa, Tulsa, Okla.....'30
‖Murray, Grover, Jr., Magnolia Petr. Co., 508 Millsaps Bldg., Jackson, Miss.....'38
‖Musselman, George A., Carter Oil Co., Box 801, Tulsa, Okla.....'39
‖Myers, Clay Kenton, c/o John G. Myers Co., Albany, N. Y.....'37
Myers, Desaix B., Union Oil Co. of Calif., Union Oil Bldg., Los Angeles, Calif.....'25
Myers, John C., independent consulting, 2109 Banks St., Houston, Tex.....'22
Myers, Julian Q., 2428 Swift Ave., Houston, Tex.....'23
‖Myers, LeMoyne W., 710 S. Chickasaw Ave., Bartlesville, Okla.....'38
Mygdal, Karl A., Pure Oil Co., Box 2107, Fort Worth, Tex.....'30
Mylius, L. A., Box 264, Centralia, Ill.....'21

Nance, A. G., Gulf Oil Corp., Box 2100, Houston, Tex.....'27
Nance, J. B., Maryland & Pennsylvania R. R. Co., 135 W. North Ave., Baltimore, Md.....'34
Nance, James W., Standard Oil Co. of Venezuela, Apt. 1329, Caracas, Venezuela, S. A.'41
Naramore, Chester, 91 Ellison Ave., Bronxville, N. Y.....'21
Nash, Howard F., Texas Petr. Co., Apt. 427, Maracaibo, Venezuela, S. A.....'20
Nash, Paul E., 721 Browder St., Dallas, Tex.....'36
Natland, M. L., Richfield Oil Corp., Long Beach, Calif.....'38
Neal, E. Preston, Tide Water Assoc. Oil Co., Tulsa, Okla.....'40
Needham, Claude E., New Mexico School of Mines, Socorro, N. Mex.....'34
Neely, Joseph, Box 629, Youngstown, Ohio.....'36
Neer, Carl J., Humble Oil & Refg. Co., Midland, Tex.....'35
‖Neighbor, Frank, Cinclair Prairie Oil Co., Ardmore, Okla.....'42
Neiler, William Dixon, The Ohio Oil Co., Box 266, Falls City, Neb.....'38
Neill, Wenzel B., Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'37
Nelimark, John H., Darby Petr. Corp., 1011 Philtower Bldg., Tulsa, Okla.....'28
Nelson, Floyd A., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'30
Nelson, James C., Aztec Oil & Royalty Co., San Antonio, Tex.....'29
Nelson, Jean O., independent, 2101 W. Summit, San Antonio, Tex.....'22
Nelson, Lloyd A., College of Mines & Metallurgy, El Paso, Tex.....'41
Nelson, Loyal E., The Texas Co., Davis, Calif.....'40
Nelson, Raymond T., Superior Oil Co., Box 278, Corpus Christi, Tex.....'37
Nelson, Richard N., N.P.P. Mij., Batavia C, Java, N.E.I.....'26
Nelson, Walter S., The Texas Co., Casper, Wyo.....'20
Nessly, Howard E., Milam Bldg., San Antonio, Tex.....'25
Netick, Joe, Orinoco Oil Co., Apt. 168, Maracaibo, Venezuela, S. A.....'29
Nettleton, L. L., Gulf Research Laboratory, Box 2038, Pittsburgh, Pa.....'30
Neuman, Leonard J., 1520 Hawthorne Ave., Houston, Tex.....'41
Neumann, Fred R., c/o John Beucher, Wheeling, Ill.....'31
Neumann, L. Murray, Carter Oil Co., Box 801, Tulsa, Okla.....'19
‖Neustadt, Walter, Jr., Ardmore, Okla.....'40
Nevin, Charles M., Dept. of Geology, Cornell University, Ithaca, N. Y.....'22
Newbill, Thomas J., Jr., Standard Oil Co. of Calif., 605 W. Olympic Blvd., Los Angeles, Calif.....'39
Newby, Jerry B., consulting, 1816 N. W. Twenty-third St., Oklahoma City, Okla. '17
Newcombe, Robert J. B., 1806 Pleasant Ave., Highland Park, Ill.....'29
‖Newell, Donald F., First Cavalry Div. Artillery, Fort Bliss, Tex.....'38
‖Newell, H. Willard, 2692 Landon Rd., Cleveland, Ohio.....'41
Newell, Norman D., Dept. of Geology, Univ. of Wisconsin, Madison, Wis.....'39

Newfarmer, Leo R., Shell Oil Co., Inc., 2000 Alamo Natl. Bldg., San Antonio, Tex..'39
‖Newhouse, Lester, c/o U. S. Engineer Office, A. P. O. 805, St. Lucia, B. W. I...'40
‖Newlon, J. H., Equitable Gas Co., 435 Sixth Ave., Pittsburgh, Pa.....'38
Newman, George H., Marsman & Co., Inc., Box 297, Manila, P. I.....'41
Newman, Thomas F., Stanolind Oil & Gas Co., Philcade Bldg., Tulsa, Okla.....'25
Newton, William A., Carter Oil Co., Box 15, Bowling Green, Ky.....'37
Newton, William W., Geotechnical Corp., 1702 Tower Petroleum Bldg., Dallas, Tex..'35
Nicholls, William M., 746 Milam Bldg., San Antonio, Tex.....'27
Nichols, C. R., Box 587, McAllen, Tex.....'20
Nichols, E. T., The California Co., Canal Bank Bldg., New Orleans, La.....'40
Nichols, Ivan K., c/o Standard Fruit Co., Puerto Cabezas, Nicaragua.....'41
‖Nichols, Norman M., Box 231, San Luis Obispo, Calif.....'40
‖Nichols, Norval W., Superior Oil Co. of New Zealand, Ltd., Suite 4, National Bank Chambers, Palmerston N., N. Z.....'37
Nichols, P. B., 3509 S. Broadway, Oklahoma City, Okla.....'29
‖Nicol, David, 4067 Mattison Ave., Fort Worth, Tex.....'38
Nicola, Oliver P., Jr., Bridger Basin Oil Co., Allegan, Mich.....'28
Nightingale, W. T., Mountain Fuel Supply Co., Rock Springs, Wyo.....'24
Nisbet, John M., Cities Service Oil Co., 705 Masonic Empire Bldg., Bartlesville, Okla.....'18
Niven, Robert N., Gulf Oil Corp., Drawer 2100, Houston, Tex.....'39
Noble, Arthur H., Anglo Saxon Petr. Co., St. Helen's Court, London, E.C. 2, England.....'24
Noble, Earl B., Union Oil Co. of Calif., 1100 Union Oil Bldg., Los Angeles, Calif...'24
Noble, Gilbert W., Missouri School of Mines, Rolla, Mo.....'26
Noble, Homer A., 3602 Overbrook Lane, Houston, Tex.....'20
Nolan, Philip Edward, Mene Grande Oil Co., Apt. 709, Caracas, Venezuela, S. A...'25
Noland, Orval W., Humble Oil & Refg. Co., LaWard, Tex.....'41
‖Noll, Donald E., Marine Corps School, B. D. W. C., Box 110, Quantico, Va.....'40
‖Nolte, Claude B., North American Oil Consolidated, Box E, Taft, Calif.....'39
Nolte, William J., Stanolind Oil & Gas Co., Fair Bldg., Fort Worth, Tex.....'23
Nomland, J. O., Standard Oil Co. of Calif., Standard Oil Bldg., San Francisco, Calif.....'28
Nordman, O. F., 126 Fortieth St., Union City, N. J.....'23
Norling, Donald L., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'38
North, Lloyd, producer, Route 1, Edinburg, Tex.....'22
Northrip, Gerald Albert, Pure Oil Co., Box 272, Madill, Okla.....'39
Norton, George H., Atlantic Refg. Co., Dallas, Tex.....'21
Norville, Glen S., consulting, 1019 Tradesmen's Natl. Bank Bldg., Oklahoma City, Okla.....'29
Notestein, Frank B., The Texas Co., Apt. 267, Caracas, Venezuela, S. A.....'20
Nowels, Kenneth B., consulting, 915 Elmwood Dr., Abilene, Tex.....'23
Nowlan, Harry H., North Central Oil Corp., 317 Court Bldg., Evansville, Ind....'21
‖Nuckolls, W. C., Carter Oil Co., Box 817, Grenada, Miss.....'40
Nufer, D. C., Burke-Greis Oil Corp., Box 268, Tulsa, Okla.....'30

Oakes, Malcolm C., Oklahoma Geol. Survey, Norman, Okla.....'24
O'Bannon, P. H., 834 W. Forty-third St., Houston, Tex.....'30
Obering, Ernest A., independent, Box 517, Mt. Vernon, Ill.....'24
Oborne, Harry W., consulting, 1328 N. Tejon Ave., Colorado Springs, Colo.....'23
O'Brien, Jerome J., 988 Pacific Electric Bldg., Los Angeles, Calif.....'38
‖Oden, Arthur J., Magnolia Petr. Co., 721 Browder St., Dallas, Tex.....'42
‖O'Donnell, Lawrence, 2409 Inwood Dr., Houston, Tex.....'34
‖O'Driscoll, Eugene Patrick, Papuan Apinaipi Petr. Co., Port Moresby, Papua..'39
‖O'Flynn, James B., Richfield Oil Corp., Haberfelde Bldg., Bakersfield, Calif...'39
Ogier, E. H., Lloyd Corp., Ltd., Los Angeles, Calif.....'31
Ohern, D. W., 515 W. Fourteenth St., Oklahoma City, Okla.....'18
O'Keeffe, H. W., Geol. Dept., Phillips Petr. Co., Bartlesville, Okla.....'30
O'Keeffe, John, Jr., Route 1, Box 170, Fellows, Calif.....'36
Olcott, David Perry, Humble Oil & Refg. Co., Box 2180, Houston, Tex.....'33
Oldham, Albert E., Aloco Oil Co., Dallas, Tex.....'25
Oles, L. M., Sinclair Prairie Oil Co., Box 1242, Amarillo, Tex.....'24
Oles, Paul S., Shasta Oil Co., Box 711, Midland, Tex.....'25

Oliphant, A. G., 2114 S. Norfolk, Tulsa, Okla.....'27
‖Oliphant, Charles W., c/o Oliphant Laboratories, Inc., 1905 Natl. Bank of Tulsa Bldg., Tulsa, Okla.....'41
Oliver, Graydon, consulting, Rm. 1229, 215 W. Seventh St., Los Angeles, Calif..'39
Olson, O. C., Box 349, Brady, Tex.....'40
‖Olson, Roland O., 1680 Roosevelt Ave., Los Angeles, Calif.....'39
Olson, Walter S., The Texas Co., 135 E. Forty-second St., New York, N. Y.....'27
‖Olson, Walter Sigfried, 104 N. Chickasaw, Bartlesville, Okla.....'41
Olsson, Axel A., consulting, 48 Woodside Ave., Gloversville, N. Y.....'20
Ongley, Montague, Geological Survey, 156 Terrace, Wellington, N. Z.....'39
Oppenheim, Victor E., consulting, Apt. 381, Bogota, Colombia, S. A.....'36
*Orcutt, W. W., Rancho Sombra del Roble, Canoga Park, Calif.....'26
‖Orchard, Paul Joseph, Continental Oil Co., Lafayette, La.....'39
*Ordoñez, Ezequiel, Abraham Gonzalez 79, Mexico City, Mex.....'24
‖Orman, Freeman, Republic Nat. Gas Co., Box 1592, Corpus Christi, Tex.....'41
Orr, Mark L., Bldg. 24–1, U. S. N. A. S., Corpus Christi, Tex.....'39
Orr, Milo M., Superior Oil Co., Box 191, Laredo, Tex.....'20
Orynski, Leonard W., Standard Oil Co. of Texas, Petroleum Bldg., Houston, Tex.'23
Osborn, William M., consulting, Box 707, Midland, Tex.....'37
Osborne, Clarence B., consulting, 402 Security Bldg., Los Angeles, Calif.....'21
Osborne, Lee S., Shell Oil Co., Inc., Box 377, Ojai, Calif.....'37
Osborne, Paul F., Koenig Bldg., 112 N. W. Fourth St., Evansville, Ind.....'30
Osborne, Robert R., Remo Royalty Co., 914 Alamo Natl. Bldg., San Antonio, Tex.....'23
Osgood, Manley, Jr., Basin Oil Co., 205 Bearinger Bldg., Saginaw, Mich.....'39
Osterhoudt, Walter J., Gulf Oil Corp., Drawer 2100, Houston, Tex.....'37
Ott, Emil, Box 186, San Angelo, Tex.....'24
‖Otton, Edmond George, III, Sinclair Wyoming Oil Co., Evansville, Ind.....'41
Owen, Edgar W., c/o L. H. Wentz, 532 Milam Bldg., San Antonio, Tex.....'19
Owen, H. J., Box 437, Lewisville, Ark.....'23
Owen, Kenneth Dale, consulting, 824 Esperson Bldg., Houston, Tex.....'27
Owens, Frith C., 213 Hendricks Bldg., Corpus Christi, Tex.....'26
Oyster, Frank A., consulting, 924 N. Broadway, Wichita, Kan.....'21

Paap, Antonie, Ned. Pac. Petr. Mij., 33 Paleisweg, Medan, Sumatra, N. E. I.....'40
Pack, Oran L., Wilshire Oil Co., Inc., Bakersfield, Calif.....'26
Pack, R. W., Sun Oil Co., Box 2831, Beaumont, Tex.....'18
Packard, Sidney A., Geol. Dept., Arkansas Nat. Gas Co., Shreveport, La.....'21
Paddleford, Jack T., 518 W. K. H. Bldg., Wichita, Kan.....'37
Page, James H., Kansas Corporation Commission, 800 Bitting Bldg., Wichita, Kan.....'25
Page, Lincoln R., U. S. Geol. Survey, Washington, D. C.....'38
Paige, Sidney, U. S. Army Engineers, 90 Church St., New York, N. Y.....'21
Palmer, Katherine V. W., Paleontological Research Inst., 126 Kelvin Pl., Ithaca, N. Y.....'28
Palmer, Leland L., W. C. McBride, Inc., 1905 Milam Bldg., San Antonio, Tex..'39
Palmer, Robert H., Neptuno 1060, Havana, Cuba.....'23
‖Parhiala, Leimo I., Dept. of Geology & Geography, Univ. of Tennessee, Knoxville, Tenn.....'39
‖Park, Noel R., 338 N. Kings Rd., Los Angeles, Calif.....'40
‖Park, Stafford, Eastman Oil Well Survey Corp., Box 408, Long Beach, Calif.....'40
Parker, Ben H., Golden, Colo.....'28
Parker, Everett C., Continental Oil Co., Box 1267, Ponca City, Okla.....'17
Parker, Frank S., Wilshire Oil Co., Inc., Los Angeles, Calif.....'35
‖Parker, Garald Gordon, 234 E. Fourteenth St., Hialeah, Fla.....'41
Parker, Jack A., Sun Oil Co., McAllen, Tex.....'36
Parker, Lloyd S., 3907 Richmond Ave., Shreveport, La.....'41
‖Parker, Norbert A., R. R. 2, Fort Wayne, Ind.....'38
Parker, T. R., Addison Drilling Co., Box 1872, Midland, Tex.....'36
‖Parker, Travis J., 202 Elmwood, Austin, Tex.....'40
‖Parker, W. G., Gulf Oil Corp., 1805 Gulf Bldg., Houston, Tex.....'38
Parks, Ernest K., consulting, 10560 Dolcedo Way, Los Angeles, Calif.....'25
Parrish, Gaston H., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex.....'25

Parsons, Claude P., Halliburton Oil Well Cementing Co., Duncan, Okla.....'27
Parsons, Harold Ewing, Shell Co. of Ecuador, Apt. 340, Quito, Ecuador, S. A.....'42
‖Parsons, Kenneth R., The Texas Co., 1408 Alamo Natl. Bldg., San Antonio, Tex.....'36
Paschal, Elisha A., Coline Oil Corp., Rm. 1202, 900 Polk St., Amarillo, Tex.....'22
‖Paschall, Robert H., Pure Oil Co., Box 1300, Bakersfield, Calif.....'39
Pasquella, George G., 515 Ramsey Tower, Oklahoma City, Okla.....'41
‖Paterson, Robert, Carter Oil Co., Box 801, Tulsa, Okla.....'39
Patnode, H. Whitman, Geol. Dept., Gulf Oil Corp., Pittsburgh, Pa.....'38
Patrick, Walden W., The Texas Co., Box 2332, Houston, Tex.....'21
Patterson, Joseph M., The Texas Co., 1408 Alamo Natl. Bldg., San Antonio, Tex..'25
Patterson, Luther Edwin, Jr., 930 N. W. Fourteenth St., Oklahoma City, Okla..'30
Patton, Jacob L., Box 428, Crowley, La.....'38
‖Patton, J. B., Magnolia Petr. Co., Box 426, Vanderbilt, Tex.....'41
Patton, Leroy T., Texas Technological College, Lubbock, Tex.....'24
Patton, Roger R., Wilcox Oil & Gas Co., Tulsa, Okla.....'29
‖Pawley, Julian K., Standard Oil Co. of Texas, Box 1249, Houston, Tex.....'40
Paxson, Roland B., consulting, 2637 University Blvd., Houston, Tex.....'26
Payne, A. L., Trinidad Leaseholds, Ltd., Forest Reserve, Trinidad, B. W. I.....'38
‖Payne, C. Winthrop, 7001 W. Thirty-eighth Ave., Wheatridge, Colo.....'38
Payne, Max B., Richfield Oil Corp., 560 Haberfelde Bldg., Bakersfield, Calif.....'38
‖Payne, Thomas G., Kansas State Geol. Survey, Lawrence, Kan.....'42
Payne, Willard M., The California Co., New Orleans, La.....'30
Peabody, Harlan W., Mid-Continent Petr. Corp., Box 381, Tulsa, Okla.....'19
Peacock, Henry Bates, Geophysical Service, Inc., 825 Esperson Bldg., Houston, Tex..'34
Peaker, Don H., Carter Oil Co., Box 801, Tulsa, Okla.....'37
Pellekaan, W. Van Holst, 701 N. Elm Dr., Beverly Hills, Calif.....'21
Pellissier, Andre, Pechelbronn S. A. E. M., Direction Generale, 32, Allee de la Robertson, Strasbourg (Bas Rhin), France.....'25
‖Pelto, Chester R., Dept. of Geology, School of Mineral Industries, Pennsylvania State College, State College, Pa.....'41
Pemberton, J. R., 1262 E. Morada Pl., Altadena, Calif.....'17
‖Pence, Richard H., California Conservation Committee, 1160 Subway Terminal Bldg., Los Angeles, Calif.....'38
Penn, William Y., consulting, Petroleum Bldg., Midland, Tex.....'41
‖Pennel, H. David, Amerada Petr. Corp., Box 3, Lafayette, La.....'37
Penny, Frederick W., Box 27, San Fernando, Trinidad, B. W. I.....'24
Perini, Vincent C., Jr., c/o Merry Bros. & Perini, Box 840, Abilene, Tex.....'23
Perkins, Joseph M., consulting, Box 147, Eastland, Tex.....'19
Perkinson, Floyd, R. F. D. #1, Purcell, Okla.....'31
Pernell, James Herbert, National Geophysical Co., 1002 Tower Petroleum Bldg., Dallas, Tex.....'41
Perrine, Irving, 1619–21 Petroleum Bldg., Oklahoma City, Okla.....'17
Perry, Waynard Burton, Seismograph Service Corp., 709 Kennedy Bldg., Tulsa, Okla.....'41
‖Pertusio, Serge M., Geol. Dept., Columbian Carbon Co., 41 E. Forty-second St., New York, N. Y.....'39
Peters, T. C., Shell Oil Co., Inc., 1012 Central Bldg., Wichita, Kan.....'41
Petersen, Harluf C., Freeport Sulphur Co., 1804 American Bank Bldg., New Orleans, La.....'40
Petersen, M. Q., Petersen Petr. Corp., 1850 Canal Bldg., New Orleans, La.....'38
Peterson, Arthur F., The Ohio Oil Co., Box 193, Bakersfield, Calif.....'40
Peterson, Clarence J., Texoma Nat. Gas Co., 4th Floor Rule Bldg., Amarillo, Tex..'19
Petrascheck, Wilhelm, Geological Museum, Mining Academy, Leoben, Austria..'28
Petrick, Glen, Stanolind Oil & Gas Co., 1132 Milam Bldg., San Antonio, Tex.....'39
Petsch, Arthur H., The Ohio Oil Co., 1417 Milam Bldg., San Antonio, Tex.....'20
Pettigrew, Virgil, Humble Oil & Refg. Co., Box 840, Wichita Falls, Tex.....'25
Petty, Dabney E., Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex.....'20
Petty, O. S., Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex.....'31
Petty, T. F., Humble Oil & Refg. Co., Box 840, Wichita Falls, Tex.....'29
‖Petty, Van A., Jr., Petty Geophysical Eng. Co., San Antonio, Tex.....'39
‖Pfaffman, George A., 1823 N. Alexandria Ave., Los Angeles, Calif.....'42
Philbrick, E. P., Magnolia Petr. Co., Box 1882, Wichita, Kan.....'23
Phillippi, W. H., Jr., West India Oil Co., San Jose, Costa Rica.....'41

‖Phillips, Ross M., 507 Natl. Mutual Bldg., Tulsa, Okla.....'39
Philpott, Thomas Hughes, Carter Oil Co., Jena, La.....'41
Phipps, J. B., Jr., Box 298, Pampa, Tex.....'33
Pickering, Warren, The California Co., Ardmore, Okla.....'42
Pickett, E. S., Union Oil Co. of Calif., Los Angeles, Calif.....'39
Picklesimer, Harold G., Arkansas Fuel Oil Co., Box 22, Hope, Ark.....'42
‖Pickrell, Daniel J., Honolulu Oil Corp., 215 Market St., San Francisco, Calif...'41
Pierce, Harold Frederick, Shell Oil Co., Inc., Box 1509, Midland, Tex.....'38
‖Piggott, Guido M., Jr., British-American Oil Prod. Co., 218 Oil & Gas Bldg., Houston, Tex.....'42
‖Pike, Sumner T., Securities & Exchange Commission, Eighteenth & Locust Sts., Philadelphia, Pa.....'37
Pike, William S., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'35
Pilcher, Ben L., The Texas Co., Box 1720, Fort Worth, Tex.....'30
Pinkley, George R., independent consulting, 144 W. Mariposa Dr., San Antonio, Tex.....'29
‖Pintea, Michael, Jr., Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A...'39
Pirson, Sylvain J., Petr. Engineering Dept., Pennsylvania State College, State College, Pa.....'35
Pirtle, George W., c/o Hudnall & Pirtle, Box 988, Tyler, Tex.....'27
Pishel, Max A., 401 Ritz Bldg., Tulsa, Okla.....'18
Pittman, C. V. A., 112 Maple Terrace Apts., Dallas, Tex.....'32
Plaster, William M., 741 Ratcliff, Shreveport, La.....'29
Plummer, F. B., Bureau of Econ. Geology, Univ. of Texas, Austin, Tex.....'19
Pogue, Joseph E., Chase Natl. Bank, 18 Pine St., New York, N. Y.....'24
Poland, Joseph F., U. S. Geol. Survey, Long Beach, Calif.....'31
Pollard, Jack C., Magnolia Petr. Co., Box 900, Dallas, Tex.....'34
‖Pollard, Robert T., 416 Terminal Bldg., Oklahoma City, Okla.....'40
Pomeyrol, Rene, Alan (Haute-Garonne), France.....'37
Ponton, G. M., 271½ St. George St., St. Augustine, Fla.....'29
‖Pool, Frank Morrow, Humble Oil & Refg. Co., Box 57, La Ward, Tex.....'41
Poole, John C., consulting, Nixon Bldg., Corpus Christi, Tex.....'34
Poor, Russell S., Birmingham-Southern College, Birmingham, Ala.....'37
Porch, Edwin L., Jr., consulting, Box 573, San Antonio, Tex.....'20
Porter, John L., 533 Havana Ave., Long Beach, Calif.....'32
‖Porter, Phil, c/o DeGolyer, MacNaughton & McGhee, 1000 Continental Bldg., Dallas, Tex.....'39
Porter, William W., 224 S. Gramcery Pl., Los Angeles, Calif.....'27
Porterfield, R. R., Devonian Oil Co., Box 1538, Midland, Tex.....'38
Pospisil, Frank J., Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A.....'29
‖Postle, Gordon L., Box 2072, Cut Bank, Mont.....'41
Poteet, James Harold, The Texas Co., Lawrenceville, Ill.....'38
‖Potsch, John Peter, consulting, 1517 S. Sixty-first Ave., Cicero, Ill.....'40
Potter, Grover C., Gilcrease Oil Co., 20th Floor Milam Bldg., San Antonio, Tex...'22
Potter, Nelson B., Cities Service Oil Co., Bartlesville, Okla.....'26
Poulin, John A., The Texas Co. (Venezuela) Ltd., Apt. 267, Caracas, Venezuela, S. A.....'32
Poulsen, Frank E., Pure Oil Co., Fair Bldg., Fort Worth, Tex.....'25
Powell, Ezra H., Magnolia Petr. Co., San Antonio, Tex.....'37
Powell, Ralph S., The Texas Co., Box 1720, Fort Worth, Tex.....'27
Power, Harry H., Dept. of Geology, Univ. of Texas, Austin, Tex.....'28
Powers, Delmer L., 347 N. Bluff Ave., Wichita, Kan.....'29
Powers, Elliot H., Gulf Oil Corp., Box 110, Amarillo, Tex.....'38
Powless, R. C., Tide Water Assoc. Oil Co., Box 1404, Houston, Tex.....'35
Pratt, Ernest S., Box 2054, Wichita, Kan.....'22
Pratt, Wallace E., Standard Oil Co. of N. J., 30 Rockefeller Plaza, New York, N. Y.....'38
Preece, Rae, Darby Petr. Corp., 817 Milam Bldg., San Antonio, Tex.....'22
‖Prescott, Gordon W., Halliburton Oil Well Cementing Co., Great Bend, Kan...'40
Pressler, Edward D., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex...'31
Preston, J. Basil, Glasgow, Ky.....'28
Price, Arthur S., Gulf Oil Corp., Box 544, Chase, Kan.....'39
Price, James A., c/o W. C. McBride, Inc., 625 Wright Bldg., Tulsa, Okla.....'36
Price, Paul H., W. Virginia Geol. Survey, Morgantown, W. Va.....'35

Price, Sylvan S., 904 Philtower Bldg., Tulsa, Okla.....'17
Price, W. Armstrong, consulting, Box 1860, Corpus Christi, Tex.....'25
Probst, Karl Max, 2220 Terwilliger Blvd., Tulsa, Okla.....'40
‖Prokesh, Hugh E., Geophysical Dept., Continental Oil Co., Ponca City, Okla...'38
‖Punches, Richard Knapp, Geol. Dept., Phillips Petr. Co., Rule Bldg., Amarillo, Tex.....'41
Purcell, Paul E. M., 701 Hamilton Bldg., Wichita Falls, Tex.....'37
Purzer, Joseph, Phillips Petr. Co., Box 1729, Shreveport, La.....'26
Putnam, George D., Lario Oil & Gas Co., 301 S. Market St., Wichita, Kan.....'27
Putnam, William C., Dept. of Geology, Univ. of California, Los Angeles, Calif...'42
‖Pye, Willard D., Dept. of Geology, Univ. of Chicago, Chicago, Ill.....'38
Pyeatt, Lloyd M., Atlantic Refg. Co., Box 1346, Houston, Tex.....'37
Pyle, Howard C., 1562 Royal Blvd., Glendale, Calif.....'29
Pyre, Augustin, Mene Grande Oil Co., Apt. 45, Barcelona, Venezuela, S. A.....'39

Quesenbery, Alice M., Cities Service Oil Co., Bartlesville, Okla.....'40
‖Quigley, James A., The Texas Co., Midland, Tex.....'42
Quiett, Roy C., producer, Box 330, Shawnee, Okla.....'22
Quinn, Robert V., General Petr. Corp., 108 W. Second St., Los Angeles, Calif...'37

Radcliffe, Donald H., Box 1468, Miami, Fla.....'20
Rae, Colin C., Skelly Oil Co., Box 1650, Tulsa, Okla.....'19
Raggatt, Harold G., Census Bldg., Canberra, A. C. T., Australia.....'36
Rainwater, Edward H., 3021 Cason St., Houston, Tex.....'38
Ralston, Wallace, Sun Oil Co., Box 2880, Dallas, Tex.....'23
Ramsey, Charles E., Ramsey Petr. Co., 3000 Ramsey Tower, Oklahoma City, Okla.....'34
Rand, Wendell P., Gulf Oil Corp., Box 1166, Pittsburgh, Pa.....'37
Rand, William W., Shell Oil Co., Inc., Box 1347, Shreveport, La.....'37
Randall, Duane C., Carter Oil Co., Box 801, Tulsa, Okla.....'39
Rank, R. A., Navarro Oil Co., Shreveport, La.....'26
Rankin, Horace Ellis, Shell Oil Co., Inc., Box 476, Centralia, Ill.....'31
‖Rankin, Robert E., 910 W. Louisiana St., Midland, Tex.....'41
Ransone, William Robert, Geophysical Service, Inc., 1311 Republic Bank Bldg., Dallas, Tex.....'33
Rath, Charles M., consulting, 1254 Cook St., Denver, Colo.....'23
‖Ratliff, Guy Marvin, 2114 Alamo Natl. Bldg., San Antonio, Tex.....'38
‖Ratway, Joseph, Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A.....'39
Rau, Harold L., consulting, 1109 N. Union St., Shawnee, Okla.....'25
Rauch, Wayne C., Geol. Dept., Lion Oil Refg. Co., El Dorado, Ark.....'27
Ray, Bernerd A., Tide Water Assoc. Oil Co., Midland, Tex.....'39
Ray, Robert H., 2501 Gulf Bldg., Houston, Tex.....'40
Ray, W. C., producer, 315 W. Twohig Ave., San Angelo, Tex.....'29
Rea, Henry Carter, 2030 McDuffie St., Houston, Tex.....'29
Reagor, Edward C., Geophysical Service, Inc., Dallas, Tex.....'39
‖Ream, Ruth, 757 S. New Hampshire Ave., Los Angeles, Calif.....'41
Reasoner, M. A., Superior Oil Co., Oil & Gas Bldg., Houston, Tex.....'38
Redfield, John S., Stanolind Oil & Gas Co., Philcade Bldg., Tulsa, Okla.....'27
‖Redfield, Robert C., 2101 Schulle Ave., Austin, Tex.....'37
Redmon, Harold E., General Exploration, Inc., 208 Miller Theatre Bldg., Wichita, Kan.....'30
Redwine, Lowell E., Geol. & Paleon. Lab., Superior Oil Co., Box 578, Shafter, Calif..'38
Reed, Charles Merton, Core Laboratories, Inc., 216 New Fowler Bldg., Centralia, Ill.....'41
‖Reed, Edward Looman, Jr., Atlantic Refg. Co., Box 871, Midland, Tex.....'41
Reed, Edwin M., 2245 Stanmore Dr., Houston, Tex.....'27
Reed, Eugene C., Conservation & Survey Div., Univ. of Nebraska, Lincoln, Neb..'28
Reed, Lyman C., Cia Romano Americana, 126 Calea Victoriei, Bucharest, Roumania.....'22
Reed, Paul C., Gulf Research & Dev. Co., Box 733, Laurel, Miss.....'40
‖Reedy, M. Frank, Jr., 832 Esperson Bldg., Houston, Tex.....'39
Reese, Donald M., 100 E. Pearl Bldg., Jackson, Miss.....'30
Reese, Richard G., Standard Oil Co. of Calif., Los Angeles, Calif.....'27
Reeside, John Bernard, Jr., U. S. Geol. Survey, Washington, D. C.....'26

Reeves, Frank, consulting, Oakland, Md.....'41
Reeves, Frank W., 2905 Merida St., Fort Worth, Tex.....'18
‖Reeves, James E., Box 808, Evansville, Ind.....'38
‖Reeves, J. R., 2002 E. Cypress St., Univ. Station, Enid, Okla.....'37
Reeves, John R., Penn-York Nat. Gas Corp., 518 Jackson Bldg., Buffalo, N. Y...'24
‖Refshauge, B. C., Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A.....'39
Regan, John H., Caripito, Venezuela, S. A.....'30
‖Regan, Louis J., Jr., 1910 Myra Ave., Los Angeles, Calif.....'41
Reger, David B., consulting, Box 816, Morgantown, W. Va.....'19
‖Rehn, E. E., Dept. of Geology, Ohio State Univ., Columbus, Ohio.....'41
Reiche, Parry, 224 S. Carlisle, Albuquerque, N. Mex.....'28
Reid, Robert P., Foster Petr. Corp., Bartlesville, Okla.....'27
Reid, William McC., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex.....'39
Reigle, Edward E., Richmond Drilling Co., Box 1547, Midland, Tex.....'28
Reinhart, Philip W., Shell Oil Co., Inc., 1008 W. Sixth St., Los Angeles, Calif...'29
‖Reiserer, Victor F., Natl. Refg. Co., 304 Kaufman Bldg., Wichita, Kan.....'37
Reisher, Paul H., Gulf Oil Corp., Box 661, Tulsa, Okla.....'21
‖Reiss, John W., Stanolind Oil & Gas Co., 2315 Gulf Bldg., Houston, Tex.....'41
Reiter, Wilhelm A., 923 Esperson Bldg., Houston, Tex.....'22
Relf, George O., Jr., Box 175, Edmond, Okla.....'39
Remington, Arthur E., Pure Oil Co., 1140 Subway Terminal Bldg., Los Angeles, Calif.....'25
Renaud, Charles L., West Texas Oil & Royalty Corp., 1905 W. T. Waggoner Bldg., Fort Worth, Tex.....'23
‖Renfro, Harold Bell, Science Hall, Univ. of Wisconsin, Madison, Wis.....'41
Renick, B. Coleman, 258 E. Rosewood Ave., San Antonio, Tex.....'25
Rennie, Waldo E., consulting, 1520 Steele St., Denver, Colo.....'25
Renz, Hans Herman, Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B. W. I. '41
Rettger, Robert E., Sun Oil Co., Box 2880, Dallas, Tex.....'25
Revelle, Roger R. D., Scripps Inst. of Oceanography, La Jolla, Calif.....'39
Reynolds, F. F., Seismic Explorations, Inc., 2911 Gulf Bldg., Houston, Tex.....'35
Reynolds, Karl W., 1136 S. Quincy, Tulsa, Okla.....'22
Reynolds, Roy A., independent consulting, 1914 Fort Worth Natl. Bank Bldg., Fort Worth, Tex.....'19
‖Reynolds, Sargent M., The Texas Co., Rm. 3, Hippodrome Bldg., Taft, Calif....'39
Rhoades, Ralph O., Gulf Oil Corp., Box 1166, Pittsburgh, Pa.....'24
Rhoades, Roy S., Majestic Oil Corp., 609 S. Grand Ave., Los Angeles, Calif.....'23
‖Rhodes, Edward J., Raritan Arsenal, Metuchen, N. J.....'31
Ribble, John M., Box 153, Phillips, Tex.....'31
‖Rice, Elmer M., Pure Oil Co., Tyler, Tex.....'27
Rich, John L., Dept. of Geology, Univ. of Cincinnati, Cincinnati, Ohio.....'19
Richards, A. H., consulting, 1622 Petroleum Bldg., Oklahoma City, Okla.....'23
Richards, Ben Howard, Carter Oil Co., Box 568, Mattoon, Ill.....'34
Richards, Edward Franklin, Univ. of Alabama, University, Ala.....'37
Richards, George L., Jr., Shell Oil Co., Inc., Ventura, Calif.....'37
Richards, J. T., Gulf Oil Corp., Box 1557, Oklahoma City, Okla.....'24
Richards, Ralph W., U. S. Geol. Survey, Washington, D. C.....'19
Richards, Raymond, Tide Water Assoc. Oil Co., Tulsa, Okla.....'25
Richardson, Carl B., Barnsdall Oil Co., 2212 Esperson Bldg., Houston, Tex.....'34
Richardson, Felix D., 1732 Polk St., Alexandria, La.....'41
Richardson, H. T., The California Co., Canal Bldg., New Orleans, La.....'30
Rickard, Hilton Lloyd, Shell Oil Co., Inc., Wichita Falls, Tex.....'41
‖Riddell, Charles Edwin, United Geophysical Co., 1255 E. Green St., Pasadena, Calif.....'38
‖Riddle, James I., Jr., independent, 2213 University Blvd., Houston, Tex.....'42
Rider, Charles R., Drilling & Exploration Co., Inc., 804 Continental Bldg., Dallas, Tex.....'20
Ries, Heinrich, 401 Thurston Ave., Ithaca, N. Y.....'26
Ries, Minette, 2619 Travis St., Houston, Tex.....'30
Rife, Byron, Missouri Ordnance Works, Louisiana, Mo.....'23
‖Rigg, Robert M., California Arabian Standard Oil Co., Jeddah, Saudi Arabia (Red Sea).....'39
‖Riggins, Leslie B., Jr., c/o C. W. Henzler, 1392 Termino, Long Beach, Calif.....'40
Riggs, George D., consulting, Box 30, Carlsbad, N. Mex.....'35

Riggs, Robert J., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla.....'17
‖Riise, J. A., Jr., Prod. Dept., Phillips Petr. Co., Bartlesville, Okla.....'39
Ring, Dewitt T., Columbia Oil & Gasoline Subsidiary, 805 Atlas Bldg., Columbus, Ohio.....'20
Ritter, Ernest A., im Sesselacker 28, Basle, Switzerland.....'30
‖Ritzius, D. E., 5140 Meridian St., Los Angeles, Calif.....'39
Rivero, Manuel, c/o Servicio Geologico, Ministerio de Obras Publicas, Caracas, Venezuela, S. A.....'35
Rixleben, Bruno, Box 60, Ada, Okla.....'27
Roach, C. B., Shell Oil Co., Inc., Box 974, Lake Charles, La.....'40
Roark, E. L., Winona Oil Co., 1020 Kennedy Bldg., Tulsa, Okla.....'22
Roark, Louis, consulting, Box 308, Tulsa, Okla.....'19
Roark, R. B., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'21
‖Robbins, H. Weston, 120 S. E. Arizona St., Portales, N. Mex.....'39
Robbins, Luther S., Superior Oil Co., 807 First Natl. Bank Bldg., Denver, Colo.....'42
‖Robbins, Raymond Willis, The Texas Co., Box 476, Mattoon, Ill.....'41
‖Roberts, Charles V., Jr., R. R. 1, Overton, Tex.....'40
Roberts, Dwight C., Sperry-Sun Well Surveying Co., Houston, Tex.....'25
‖Roberts, Gerald C., Amerada Petr. Corp., Seminole, Tex.....'38
Roberts, Homer E., Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex.....'41
Roberts, Louis C., Jr., 514 Oil & Gas Bldg., Houston, Tex.....'25
Roberts, M. C., The Texas Co., Box 1007, Shawnee, Okla.....'37
‖Roberts, Richard L., Transwestern Oil Co., Grand Rapids, Mich.....'41
Roberts, Thomas N., Mid-Continent Petr. Corp., Box 1362, Wichita, Kan.....'35
Robertson, G. K., Box 849, Santa Paula, Calif.....'38
Robertson, Parker A., Gulf Oil Corp., Box 778, Tyler, Tex.....'23
‖Robichaux, Douglas B., Box 147, Jeanerette, La.....'40
‖Robie, Robert Hodges, Albany, Tex.....'40
Robinson, B. F., consulting, 709 E. Thirteenth St., Cameron, Tex.....'21
Robinson, Cecil D., Arkansas Fuel Oil Corp., 116 Commercial Bldg., McAllen, Tex.'28
Robinson, Ernest Guy, Shell Oil Co., Inc., Box 476, Centralia, Ill.....'22
Robinson, Heath M., independent, 1005 Gulf States Bldg., Dallas, Tex.....'22
Robinson, J. French, East Ohio Gas Co., 1405 E. Sixth St., Cleveland, Ohio.....'20
‖Robinson, Joseph, 816 Sumner Ave., Springfield, Mass.....'41
Robinson, Van D., Atlantic Refg. Co., 1001 City Bank Bldg., Shreveport, La...'37
Robinson, W. I., Dept. of Geology, Texas Technological College, Lubbock, Tex...'22
Rogatz, Henry, consulting, 301 Rule Bldg., Amarillo, Tex.....'25
Rogers, Andrew J., Box 87, Mound City, Mo.....'37
Rogers, Harry Samuel, Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B. W. I.....'40
Rogers, James K., Arkansas Fuel Oil Co., 1704 Milam Bldg., San Antonio, Tex...'37
Rogers, Jesse A., The Texas Co., Box 1221, Pampa, Tex.....'38
Rogers, Maynard, 2909 E. Mulberry, Evansville, Ind.....'39
Rogers, Victor W., Shell Oil Co., Inc., Midland, Tex.....'37
Rohr, Karl, Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B. W. I.....'41
Rohwer, F. W., 1433 Pine St., Boulder, Colo.....'24
Rolshausen, F. W., Humble Oil & Refg. Co., 1068 Humble Bldg., Houston, Tex...'28
Romans, William A., Box 168, Baton Rouge, La.....'37
Romine, Thomas B., Sinclair Prairie Oil Co., Box 1990, Fort Worth, Tex.....'23
‖Ronbeck, Arthur C., Superior Oil Co., Houma, La. (Last address).....'40
Roop, Charles W., 3560 E. Douglas, Wichita, Kan.....'22
Roper, Frank C., c/o Roper & Todd, Esperson Bldg., Houston, Tex.....'36
Rosaire, E. E., Subterrex, 701 Waugh Dr., Houston, Tex.....'31
Roschen, Ernest C. H., Caixa Postal 1236, Loanda, Angola, Portuguese West Africa.....'29
Rose, Harrison W., Sun Oil Co., Beaumont, Tex.....'30
Rose, Nicholas, U. S. Geol. Survey, Houston, Tex.....'40
‖Rose, Stanford L., 618 Simpson Bldg., Ardmore, Okla.....'38
Rosenkrans, R. R., 3 N. Meridian, Redkey, Ind.....'41
Ross, Charles M., Geophysical Research Corp., Box 2040, Tulsa, Okla.....'29
Ross, Donald A., consulting, Box 83, Corpus Christi, Tex.....'39
Ross, E. McIver, Jr., Amerada Petr. Corp., 1811 Esperson Bldg., Houston, Tex...'34
‖Ross, J. D., Marsman & Co., Inc., Box 3404, Manila, P. I.....'38

Ross, John C., 414 W. Craig Pl., San Antonio, Tex. . . . '21
Ross, Ralph B., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa. . . . '37
Roth, Robert, Humble Oil & Refg. Co., Box 840, Wichita Falls, Tex. . . . '29
Rothrock, E. P., Univ. of South Dakota & State Geol. Survey, Vermillion, S. D. . . '19
Rothrock, Howard E., Natl. Park Service, U. S. Dept. of the Interior, Washington, D. C. . . . '21
Rothwell, W. Thomas, Richfield Oil Corp., Box 470, Long Beach, Calif. . . . '38
Rouse, John T., Magnolia Petr. Co., 508 Millsaps Bldg., Jackson, Miss. . . . '38
Rousselot, Norman A., Seaboard Oil Co., 970 Subway Terminal Bldg., 417 S. Hill St., Los Angeles, Calif. . . . '27
Row, Charles H., Sun Oil Co., 832 Milam Bldg., San Antonio, Tex. . . . '19
Roy, Chalmer J., Univ. of Louisiana, Geol. Dept., Baton Rouge, La. . . . '37
‖Royds, James S., Continental Oil Co., 330 Continental Bldg., Ponca City, Okla. . . '40
Rozlosnik, Andres, Cordoba 612, 6th Piso, Department A, Buenos Aires, Argentina, S. A. . . . '37
Ruby, Glen M., 1035 Bartlett Bldg., Los Angeles, Calif. . . . '22
‖Rudd, Eric A., Broken Hill Prop. Co., Ltd., 422 Little Collins St., Melbourne, Vic., Australia . . . '34
Rudolph, Paul Jackson, Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex. . . . '39
Rumsey, Edward W., Shell Oil Co., Inc., 814 Rule Bldg., Amarillo, Tex. . . . '30
‖Rumsey, Nelson J., Jr., 5436 Fair Oaks Ave., Pittsburgh, Pa. . . . '40
‖Runion, Felix A., Humble Oil & Refg. Co., 941 Humble Bldg., Houston, Tex. . . '38
Rupnik, John J., 364 S. Hudson Ave., Pasadena, Calif. . . . '33
Rusk, Willard W., Amarillo Oil Co., Amarillo, Tex. . . . '26
Russ, Leon F., Southwood Oil Co., 805 Continental Bldg., Dallas, Tex. . . . '19
Russell, C. A., consulting engineer & producer, 1802 Esperson Bldg., Houston, Tex. . . . '29
‖Russell, Harry J., Jr., Gulf Oil Corp., 1107 Union Natl. Bank Bldg., Wichita, Kan. . . . '41
Russell, Hewlett A., Standard Oil Co. of Texas, Box 1660, Midland, Tex. . . . '29
Russell, J. J., Jr., Sinclair Prairie Oil Co., 504 Hamilton Bldg., Wichita Falls, Tex. . . '29
Russell, P. G., Lone Star Gas Co., Box 2837, Dallas, Tex. . . . '21
Russell, R. Dana, School of Geology, Louisiana State Univ., Baton Rouge, La. . . '27
Russell, Richard Joel, Louisiana State Univ., Baton Rouge, La. . . . '37
Russell, William L., Well Surveys, Inc., Tulsa, Okla. . . . '24
Russo, Martin, Sun Oil Co., McAllen, Tex. . . . '38
Russom, Vaughn W., Box 695, Hobart, Okla. . . . '21
Ruth, John William, Standard Oil Co. of Calif., Los Angeles, Calif. . . . '39
Rutledge, R. B., Skelly Oil Co., Box 1650, Tulsa, Okla. . . . '26
Ruwwe, John W., Geol. Dept., Phillips Petr. Co., Bartlesville, Okla. . . . '38
Ryan, R. G. "Rex," 1215 W. Russell Pl., San Antonio, Tex. . . . '23
‖Ryan, Thomas P., Raritan Arsenal, Metuchen, N. J. . . . '42
Ryniker, Charles, Gulf Oil Corp., Box 661, Tulsa, Okla. . . . '25

Sackett, H. F., The Fisher Oil Co., 317 Court Bldg., Evansville, Ind. . . . '27
Safonov, Anatole, Union Prod. Co., Shreveport, La. . . . '39
Salas, G. P., c/o Dept. Geol., Petroleos Mexicanos, Tampico, Tamps., Mex. . . . '37
Sale, Clarence M., 3741 Purdue, Dallas, Tex. . . . '24
Salvatori, Henry, Western Geophysical Co., 711 Edison Bldg., Los Angeles, Calif. . . '30
‖Samford, Finis Mack, Box 497, New Orleans, La. . . . '41
Sammons, George B., independent, 327 S. Clifton St., Wichita, Kan. . . . '24
Sample, Charles Hurst, Houston Oil Co., Box 2412, Houston, Tex. . . . '34
Sampson, Edward, Princeton University, Guyot Hall, Princeton, N. J. . . . '36
Samuell, John Howard, consulting, Box 1117, Fort Stockton, Tex. . . . '26
Sanders, C. W., Jr., Geol. Dept., Shell Oil Co., Inc., Box 2099, Houston, Tex. . . . '27
Sanderson, J. O. G., consulting, 219 Lougheed Bldg., Calgary, Alta., Canada . . . '28
Sandidge, John R., Magnolia Petr. Co., 1704 Alamo Natl. Bldg., San Antonio, Tex. . . . '29
Sandifer, Donald F., Stanolind Oil & Gas Co., 1132 Milam Bldg., San Antonio, Tex. . . . '41
Sands, Charles D., The Ohio Oil Co., Box 253, Lafayette, La. . . . '38
Sands, J. M., Phillips Petr. Co., Bartlesville, Okla. . . . '17

‖Sanford, Wendell Glenn, The Texas Co., Box 600, Wichita Falls, Tex.....'40
Sansone, John B., Union Pacific R. R., Oil Div., 408 Roach Bldg., Laramie, Wyo...'37
Sappington, Chester, General Geophysical Co., Gulf Bldg., Houston, Tex.....'28
Sargent, E. C., Second & Yoakum, Kingsville, Tex.....'30
Sartain, Max R., Pan-American Prod. Co., 1245 Mellie Esperson Bldg., Houston, Tex.....'41
Sass, Louis Carl, 624 Steele St., Denver, Colo.....'34
Sasse, Jerome B., 2104 Morse, Houston, Tex.....'29
Saunders, Lowell, consulting, 2731 Eighteenth St., Bakersfield, Calif.....'36
‖Savage, John D., United British Oilfields of Trinidad, Ltd., Point Fortin, Trinidad, B. W. I.....'40
Saville, C. William, Texas Petr. Co., Apt. Postal 877, Bogota, Colombia, S. A.....'37
Saville, Wilson G., 1348 Esperson Bldg., Houston, Tex.....'29
Sawtelle, George, Kirby Petr. Co., Houston, Tex.....'22
Sawyer, Joseph Herbert, Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A...'39
Say, Stanley R., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'25
Sayre, A. Nelson, U. S. Geol. Survey, Washington, D. C.....'41
Schaeffer, Hugh C., United Geophysical Co., 3416 N. W. Twentieth St., Oklahoma City, Okla.....'26
Schafer, Sidney, Tide Water Assoc. Oil Co., Box 1404, Houston, Tex.....'36
‖Schall, Fred M., Jr., The Texas Co., Box 252, New Orleans, La.....'41
‖Schaub, Hans Peter, Caribbean Petr. Co., Apt. Postal 19, Maracaibo, Venezuela, S. A.....'41
Schenck, Hubert G., Box 1528, Stanford University, Calif.....'28
Scherer, Oliver J., Soil Conservation Service, Lincoln, Neb.....'42
Schillhahn, E. O., Manufacturers Light & Heat Co., 800 Union Trust Bldg., Pittsburgh, Pa.....'31
Schilling, Karl H., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'23
Schlaich, E. P., De Bataafsche Petr. Mij., Balikpapan, Borneo, N. E. I.....'34
Schlosser, Paul A., Phillips Petr. Co., Box 1783, Midland, Tex.....'23
Schlumberger, Marcel, Societe de Prospection Electrique, 30 Rue Fabert, Paris, VII, France.....'37
Schmeeckle, Walter C., General Geophysical Co., Box 1696, Bakersfield, Calif.....'40
Schmidt, Karl A., 3318 Oakdale, Houston, Tex.....'25
Schmotzer, J. W., Arkansas Fuel Oil Co., Box 283, Houston, Tex.....'31
Schneider, G. W., The Texas Co., Box 252, New Orleans, La.....'25
Schneider, William T., Honolulu Oil Corp., Drawer 1391, Midland, Tex.....'37
Schnurr, Cornelius, consulting, Box 1343, Midland, Tex.....'22
Schoeneck, Philip S., Atlantic Refg. Co., 1742 Milam Bldg., San Antonio, Tex...'21
Scholl, Guy J., consulting, Panhandle Bldg., Wichita Falls, Tex.....'29
Scholl, Louis A., Jr., The Texas Co., Box 2332, Houston, Tex.....'19
Schoolfield, R. F., producer, 1825 Alamo Natl. Bldg., San Antonio, Tex.....'21
‖Schoonmaker, George R., The Ohio Oil Co., Casper, Wyo.....'41
Schoonover, Jack Gardner, Colombian Petr. Co., Cucuta, Colombia, S. A.....'41
Schouten, Franklin H., Stanolind Oil & Gas Co., Box 1410, Fort Worth, Tex.....'26
Schramm, E. F., Morrill Hall, Rm. 112, Univ. of Nebraska, Lincoln, Neb.....'19
Schroeder, Kingsley V., Sun Oil Co., Box 2831, Beaumont, Tex.....'39
*Schuchert, Charles, Yale University, New Haven, Conn.....'19
‖Schuldt, Walter C., Carter Oil Co., Wichita, Kan.....'41
‖Schultz, Frank August, 3000 Yale Ave., Apt. 3, Dallas, Tex.....'41
Schulz, William M., Cities Service Oil Co., Box 149, Mt. Pleasant, Mich.....'40
Schumacher, J. P., Torsion Balance Expl. Co., 1348 Esperson Bldg., Houston, Tex.'24
Schürmann, H. M. E., Waalsdorperweg 149, The Hague, Netherlands.....'31
Schwabrow, John R., U. S. Geol. Survey, Box 565, Thermopolis, Wyo.....'27
‖Schwartz, Channing B., Standard Oil Co. of La., Drawer 1739, Shreveport, La...'40
Schwartz, H. E., Cambrian Oil Co., 203 Combs & Worley Bldg., Pampa, Tex.....'30
Schwarz, Melbert E., Seaboard Oil Co., Dallas, Tex.....'25
Schweer, Henry F., 600 Eubanks, Oklahoma City, Okla.....'28
Schweers, Richard Henry, The Texas Co., Box 1720, Fort Worth, Tex.....'39
Schwennesen, Alvin T., 5701 Jackson St., Houston, Tex.....'25
Sclater, Kenneth, The Petroleum Engineer, 700 Allen Bldg., Dallas, Tex.....'26
Scobey, Ellis H., Gulf Refg. Co., Box 106, Indianapolis, Ind.....'40
‖Scott, David Holcomb, The Texas Co., Bakersfield, Calif.....'40

Scott, Edward W., Union Oil Co. of Calif., Ventura, Calif. '35
Scott, Edwin Cooper, Trinidad Leaseholds, Ltd., Berks, England '37
Scott, Gayle, Texas Christian Univ., Fort Worth, Tex. '21
Scott, Gerald H., Apex (Trinidad) Oilfields, Ltd., P. O. Siparia, Trinidad, B. W. I. '35
Scott, H. M., 301 Beacon Bldg., Tulsa, Okla. '21
Scott, Horace L., consulting, Huntsville, Ark. '28
Scott, Vernon C., The Texas Co., Box 476, Mattoon, Ill. '31
Scott, Wilton E., Cities Service Oil Co., Drawer G, Hobbs, N. Mex. '40
‖Scrafford, John Bruce, Richardson Petr. Co., Nixon Bldg., Corpus Christi, Tex. '39
Scrogin, John M., Box 489, Rosenberg, Tex. '39
Scruggs, M. Dale, 2223 Bellaire Blvd., Houston, Tex. '26
Scudder, E. W., Gulf Oil Corp., Box 661, Tulsa, Okla. '17
Seager, O. A., Carter Oil Co., Box 358, Bismarck, N. D. '35
Seale, Robert I., Schlumberger Well Surveying Corp., 1004 Continental Bldg., Dallas, Tex. '31
Sealey, Fred C., The Texas Co., 135 E. Forty-second St., New York, N. Y. '20
‖Seals, Wilburn Hall, 1609 Broadway, New Orleans, La. '40
Seaman, L. O., Sinclair Priarie Oil Co., Box 521, Tulsa, Okla. '28
‖Sears, David Hume, 606 E. Fifth St., Madera, Calif. '40
‖Sears, Joseph M., 525 W. Thirty-fifth St., Oklahoma City, Okla. '40
Sears, Julian D., U. S. Geol. Survey, Washington, D. C. '24
Seashore, Paul T., Louisiana Land & Expl. Co., Houma, La. '27
Secor, Dana M., Box 1485, Midland, Tex. '28
Secor, Donald T., United Nat. Gas Co., 308 Seneca St., Oil City, Pa. '38
‖Seedle, Charles W., Arkansas Fuel Oil Co., New Orleans, La. '40
Seevers, Harris N., Shasta Oil Co., Corpus Christi, Tex. '27
Seifert, Wilbur H., United Nat. Gas Co., Box 284, Oil City, Pa. '32
Seitz, J. R., Seitz-Comegys & Seitz, 532–4 Waggoner Bldg., Wichita Falls, Tex. '24
Self, Selden R., Amerada Petr. Corp., Box 2026, Tyler, Tex. '29
Selig, A. L., Stanolind Oil & Gas Co., Box 3092, Houston, Tex. '23
Selk, Erwin L., Stanolind Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan. '38
Sellards, E. H., Univ. of Texas, Bur. of Economic Geology, Austin, Tex. '19
Sellin, H. A., Magnolia Petr. Co., Box 128, Mattoon, Ill. '39
Semmes, Douglas R., Sarnosa Oil Corp., 1701 Milam Bldg., San Antonio, Tex. '19
Senn, Alfred, British Union Oil Co., Ltd., Box 177, Barbados, B. W. I. '38
Senseman, R. B., Union Prod. Co., Beeville, Tex. '38
‖Seren, Gordon W., The Texas Co., Box 2332, Houston, Tex. '39
Severson, George A., Av. L. N., Alem 619, Buenos Aires, Argentina, S. A. '26
Severy, C. L., 322 N. Sixth St., Fort Smith, Ark. '17
‖Shade, E. Bruce, The Ohio Oil Co., Findlay, Ohio '42
Shaffer, John M., Prospect, Pa. '38
Shakely, Ed., Shell Oil Co., Inc., Box 2099, Houston, Tex. '25
Shamblin, W. Earle, Devonian Oil Co., Tulsa, Okla. '27
‖Shannon, Sherril A., 1507 Broadway, Great Bend, Kan. '38
Sharpe, Joseph A., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla. '40
Shaub, Benjamin M., Dept. of Geology, Smith College, Northampton, Mass. '32
‖Shaw, Charles A., Sun Oil Co., Box 1682, Midland, Tex. '42
Shaw, Everett S., 3131 Zenobia St., Denver, Colo. '22
Shaw, Silas Frederick, consulting engineer, 301 Terrill Rd., San Antonio, Tex. '27
Shay, D. C., consulting, Box 941, Baton Rouge, La. '30
Shayes, Fred P., United Prod. Corp., Beeville, Tex. '23
Shea, E. F., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla. '21
Shearer, Harold K., The Hunter Co., Inc., Box 532, Shreveport, La. '20
Shearer, Louis H., Core Laboratories, Inc., 708 Santa Fe Bldg., Dallas, Tex. '41
Sheets, Martin M., Stanolind Oil & Gas Co., Box 3092, Houston, Tex. '40
Shelby, Thomas, Jr., Humble Oil & Refg. Co., Box 2025, Tyler, Tex. '35
Sheldon, Dean H., c/o R. E. Havenstrite, 811 W. Seventh St., Los Angeles, Calif. '39
Sheldon, Israel R., 537 Milam Bldg., San Antonio, Tex. '21
Sheldon, Robert A., Geol. Dept., Tropical Oil Co., Barranca-Bermeja, Colombia, S. A. '37
‖Sheldon, Wichita F., National Geophysical Co., Tower Petroleum Bldg., Dallas, Tex. '40

‖Sheller, James Warner, Box 455, Studio City Station, N. Hollywood, Calif.....'39
Shelton, George H., 1712 Milam Bldg., San Antonio, Tex.....'27
Shepard, Francis P., Geol. Dept., Univ. of Illinois, Urbana, Ill.....'37
Shepherd, G. Frederick, 125 Harding St., New Orleans, La.....'38
Sherar, Edgar Smith, Tide Water Assoc. Oil Co., Box 1404, Houston, Tex.....'34
Sherar, Stuart, Trinity Petr. Co., Esperson Bldg., Houston, Tex.....'35
‖Sherbondy, William Everett, 2425 W. Thirty-fifth Ave., Denver, Colo.....'40
Sherborne, John E., Union Oil Co. of Calif., Box 807, Santa Fe Springs, Calif.....'41
Sherman, Richard W., Security Title Ins. Bldg., 530 W. Sixth St., Los Angeles, Calif.....'28
Sherman, Roger H., Standard Oil Co. of Venezuela, Apt. 1329, Caracas, Venezuela, S. A.....'32
Sherrill, Richard E., Geology Dept., Univ. of Pittsburgh, Pittsburgh, Pa.....'27
Sherry, William J., producer, 841 Kennedy Bldg., Tulsa, Okla.....'27
Sherwin, M. W., Sun Oil Co., Box 2880, Dallas, Tex.....'39
Shiarella, Nicholas W., 405 W. Thirteenth St., Owensboro, Ky.....'22
Shields, Fred C., consulting, 919 Hightower Bldg., Oklahoma City, Okla.....'28
‖Shirk, Wilmer R., Cities Service Oil Co., Bartlesville, Okla.....'40
‖Shoemaker, Richard Walter, The Ohio Oil Co., Box 193, Bakersfield, Calif.....'39
Shoenfelt, C. E., Petroleum Information, Inc., 240–42 Continental Oil Bldg., Denver, Colo.....'28
Short, Richard T., Navarro Oil Co., Alice, Tex.....'35
Shuler, Ellis W., Southern Methodist Univ., Dallas, Tex.....'19
Shutt, Roscoe E., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'23
Sickler, Jack M., consulting, 422 Security Title Bldg., Los Angeles, Calif.....'19
Sidwell, Raymond, Geol. Dept., Texas Technological College, Lubbock, Tex.....'28
Siegfus, Stanley S., 300 Balsam Ave. (Skyline Park), Bakersfield, Calif.....'28
Sielaff, Robert L., Sinclair Wyoming Oil Co., Box 1809, Casper, Wyo.....'39
Silverman, Daniel, Stanolind Oil & Gas Co., Box 591, Tulsa, Okla.....'42
Simkins, J. J., 5614 Bell St., Dallas, Tex.....'35
Simmons, Arthur C., consulting, Box 191, Bradford, Pa.....'39
Simmons, Benjamin Titus, 803 Shell Bldg., Houston, Tex.....'39
‖Simmons, Harvey J., Jr., Godfrey L. Cabot, Inc., Box 348, Charleston, W. Va...'38
Simmons, Kenneth A., W. C. McBride, Inc., Box 425, Centralia, Ill.....'29
Simmons, Rouse, 418 Bartlett Bldg., Los Angeles, Calif.....'26
Simon, Louis J., The Texas Co., 929 S. Broadway, Los Angeles, Calif.....'37
‖Simonson, Russell R., 211 Philippine St., Taft, Calif.....'39
Simonton, Owen W., Box 194, Mattoon, Ill.....'31
Simpson, Edward C., Superior Oil Co., 930 Edison Bldg., Los Angeles, Calif.....'37
Simpson, Richard W., Jr., 1206 Philtower Bldg., Tulsa, Okla.....'30
‖Simpson, Roscoe M., Cardinal Oil Co., Box 1030, San Angelo, Tex.....'39
‖Sinclair, John Taylor, Jr., Tide Water Assoc. Oil Co., Box Y, Los Nietos, Calif...'41
Sinclair, W. B., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'34
Singewald, Joseph T., Jr., Johns Hopkins Univ., Baltimore, Md.....'21
†Singewald, Quentin D., Univ. of Rochester, Rochester, N. Y.....'27
Sisney, E. W., Cities Service Oil Co., Box 4577, Oklahoma City, Okla.....'41
Sisson, Harry Hensel, General Geophysical Co., 2513–14 Gulf Bldg., Houston, Tex.....'41
Siverson, G. C., consulting, 4913 E. Fifth Pl., Tulsa, Okla.....'27
Skeels, Dorr Covell, Standard Oil Co. of N. J., 30 Rockfeller Plaza, New York, N. Y.....'40
Skinner, John Wesley, Humble Oil & Refg. Co., Box 1600, Midland, Tex.....'38
Sklar, Maurice, Box 566, Pearsall, Tex.....'41
Sleight, Glenn C., Sun Oil Co., Mt. Pleasant, Mich.....'40
Slipper, S. E., Canadian Western Nat. Gas, Light, Heat & Power Co., Ltd., 215 Sixth Ave., West, Calgary, Alta., Canada.....'23
Sloan, Raymond D., Carter Oil Co., Box 801, Tulsa, Okla.....'36
Sloss, James P., c/o W. C. McBride, Inc., 1904 Milam Bldg., San Antonio, Tex...'39
Small, Walt M., Cooperstown, Pa.....'17
Smalley, Claire F., consulting, 722 N. Eighth St., Duncan, Okla.....'31
Smedley, Harold O., Skelly Oil Co., 510 Ellis-Singleton Bldg., Wichita, Kan.....'28
Smiley, H. F., consulting, 624 Hamilton Bldg., Wichita Falls, Tex.....'23
Smiser, Jerome S., consulting, 1503 Mellie Esperson Bldg., Houston, Tex.....'30

Smith, A. E., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'31
Smith, Aylwin L., Independent Expl. Co., 901 Esperson Bldg., Houston, Tex.....'37
‖Smith, Colin Hubbard, R. D. 1, Box 90-E, Pasadena, Calif.....'31
Smith, Ernest Rice, Dept. of Geology, DePauw Univ., Greencastle, Ind.....'36
Smith, Erwin W., 2202 Esperson Bldg., Houston, Tex.....'24
‖Smith, Eugene W., 4319 Lafayette St., Dallas, Tex.....'39
Smith, Fred E., 841 M. & M. Bldg., Houston, Tex.....'37
‖Smith, Fred Lewis, Jr., Atlantic Refg. Co., Box 1346, Houston, Tex.....'39
Smith, George J., Shell Oil Co., Inc., 1008 W. Sixth St., Los Angeles, Calif.....'27
*Smith, George Otis, Box 308, Skowhegan, Me.....'26
Smith, Gerald J., Pan-American Prod. Co., 1245 Mellie Esperson Bldg., Houston, Tex.....'37
‖Smith, Gerald N., 1521 N. W. Thirty-first St., Oklahoma City, Okla.....'27
Smith, Hampton, The Texas Co., 929 S. Broadway, Los Angeles, Calif.....'30
Smith, J. Fred, Jr., Texas A. & M. College, Dept. of Geology, College Station, Tex.....'40
Smith, J. P., Box 169, Weatherford, Tex.....'39
Smith, J. Peter, 514 Orpheum Bldg., Wichita, Kan.....'38
Smith, Julian W., Eason Oil Co., Mt. Vernon, Ill.....'30
Smith, Knowles B., Univ. of Notre Dame, South Bend, Ind.....'38
Smith, Lee C., Sun Oil Co., Box 1149, McAllen, Tex.....'31
Smith, Lloyd B., 2617 Dillard St., Shreveport, La.....'20
‖Smith, Lorne A., International Petr. Co., Apt. 803, Guayaquil, Ecuador, S. A...'41
‖Smith, Lyle W., Shell Oil Co., Inc., Long Beach, Calif.....'40
Smith, Marcus A. J., Iowa Ordnance Plant, Army, Burlington, Iowa.....'40
Smith, Merritt B., 9500 Santa Monica Blvd., Beverly Hills, Calif.....'22
‖Smith, Millard Wesley, Anderson-Prichard Oil Corp., 302 Bitting Bldg., Wichita, Kan.....'41
‖Smith, Neal J., The California Co., 1818 Canal Bldg., New Orleans, La.....'39
‖Smith, Norman C., 15 Oxford St., Cambridge, Mass.....'40
‖Smith, R. Hendee, School of Geology, Baton Rouge, La.....'40
‖Smith, Ralph E., 904 College Ave., Norman, Okla.....'38
Smith, Richard A., Geol. Survey Division, State Office Bldg., Lansing, Mich.....'22
Smith, Robert Harlowe, consulting, 863 Merrifield St., S. E., Grand Rapids, Mich.....'27
Smith, Rufus M., Panhandle Eastern Pipe Line Co., 505 Fairfax Bldg., Kansas City, Mo.....'38
Smith, Wayne M., Wilshire Oil Co., Inc., Los Angeles, Calif.....'28
Smoots, John P., Standard Oil Co., 1766 Midland Bldg., Cleveland, Ohio.....'22
‖Snebold, William F., 2331 Medford Court East, Fort Worth, Tex.....'35
Snedden, Loring B., The Texas Co., Bakersfield, Calif.....'37
Snider, George W., Box 234, Evansville, Ind.....'24
Snider, L. B., consulting, 717 Milam Bldg., San Antonio, Tex.....'19
Snider, L. C., Dept. of Geology, Univ. of Texas, Austin, Tex.....'18
Snively, H. Norman, Box 854, Laramie, Wyo.....'23
Snow, Arthur Leland, Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex...'41
Snow, Dale R., Barnsdall Oil Co., Box 2039, Tulsa, Okla.....'20
‖Snow, Robert D., Graduate House, Massachusetts Inst. of Technology, Cambridge, Mass.....'41
‖Snyder, Raymond W., 751 Quebec, Denver, Colo.....'38
Sohlberg, Rudolph G., Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif.....'38
‖Sohn, Israel G., Rm. 17, U. S. Natl. Museum, Washington, D. C.....'38
Solari, Allison Jarvis, Standard Oil Co. of Calif., Sonora, Calif.....'37
Solliday, A. L., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla.....'22
Somers, George B., 4336 Bowser Ave., Dallas, Tex.....'38
Somers, Ransom E., Gulf Oil Corp., Box 1166, Pittsburgh, Pa.....'19
Soper, E. K., Dept. of Geology, Univ. of California at Los Angeles, Los Angeles, Calif.....'25
Sorenson, I. L., Humble Oil & Refg. Co., 905 Humble Bldg., Houston, Tex.....'31
Sorge, Barthold William, United Geophysical Co., 1255 E. Green St., Pasadena, Calif.....'41
‖Sorrells, Warren D., Standard Oil Co. of Venezuela, Caripito, Venezuela, S. A...'39

Souther, John B., 239 Luther Dr., San Antonio, Tex. . . . '24
Soyster, M. H., consulting, 4321 Clinton, Los Angeles, Calif. . . . '27
Spahr, Marshall Richard, Carter Oil Co., Box 801, Tulsa, Okla. . . . '38
‖Spain, David S., 408 S. Tenth, Ponca City, Okla. . . . '40
Spangler, Grant W., Stanolind Oil & Gas Co., Box 1099, Shawnee, Okla. . . . '25
Sparenberg, G. R., Lane-Wells Co., Box 531, New Iberia, La. . . . '39
Spears, Walter H., Union Prod. Co., Box 1407, Shreveport, La. . . . '28
Speed, C. D., Jr., Speed Oil Co., 1315 Second Natl. Bank Bldg., Houston, Tex. . . . '30
Speer, George W., 3420 Elmwood Dr., Wichita, Kan. . . . '37
‖Spencer, Charles G., 408 S. Henderson, Bloomington, Ind. . . . '41
Spencer, Maria, Superior Oil Co., Box 510, Midland, Tex. . . . '30
Spice, William H., Jr., 2101 Alamo Natl. Bldg., San Antonio, Tex. . . . '24
Spieker, Edmund M., Ohio State Univ., Dept. of Geology, Columbus, Ohio. . . . '23
Spofford, Howard N., consulting, 3427 Beverly Pl., Shreveport, La. . . . '24
Spooner, K. K., Atlantic Refg. Co., 901 Tower Bldg., Jackson, Miss. . . . '36
Spooner, W. C., consulting, Box 1195, Shreveport, La. . . . '18
Spoor, Harry C., Jr., consulting, 1528 Commerce Bldg., Houston, Tex. . . . '28
Sprague, Robert D., Sinclair Prairie Oil Co., Box 1710, Baton Rouge, La. . . . '33
Sprague, William B., c/o J. L. Collins & Co., San Antonio, Tex. . . . '24
Spratt, J. G., The Anglo Canadian Oil Co., Ltd., Lancaster Bldg., Calgary, Alta., Canada . . . '30
Spratt, Robert Elmer, U. S. Geol. Survey, 208 Custom House, Denver, Colo. . . . '42
‖Sprengling, Kurt, c/o DeGolyer, MacNaughton & McGhee, 1000 Continental Bldg., Dallas, Tex. . . . '41
Sproule, John Campbell, Northwest Co., Ltd., 606 Second St. W., Calgary, Alta., Canada . . . '40
Sprowls, Harlan A., 120 N. Third St., Vincennes, Ind. . . . '27
‖Sreshthaputra, Vija, Thai Geological Survey, 1483 B, Lad Ya, Dhonburi, Thailand . . . '40
St. Clair, Donald W., Shell Oil Co., Inc., Box 1191, Tulsa, Okla. . . . '36
St. Clair, Stuart, consulting, Hudson View Gardens, One Hundred Eighty-third St. & Pinehurst Ave., New York, N. Y. . . . '19
St. Germain, R. J., producer, 1438 Commerce Bldg., Houston, Tex. . . . '26
Stacy, Dean M., Royalty Service Corp., Ltd., 707 Richfield Bldg., 555 S. Flower St., Los Angeles, Calif. . . . '17
Staehelin, Peter Karl, Bernerring 64, Basle, Switzerland . . . '30
Stafford, Clare J., Box 141, Wichita, Kan. . . . '27
Stainbrook, Merrill A., Texas Technological College, Lubbock, Tex. . . . '29
Stalder, Walter, consulting, 919 Crocker Bldg., San Francisco, Calif. . . . '22
Staley, Glenn, Proration Office, Hobbs, N. Mex. . . . '30
‖Stall, Trovall Lafayette, 415 Alexander Bldg., Abilene, Tex. . . . '40
Stamey, Roderick A., 2123 North Blvd., Houston, Tex. . . . '31
‖Stanley, Ben, Jr., 647 E. Cypress Ave., Bastrop, La. . . . '40
Stanley, E. R., c/o Stanley & Stolz, 510 S. Spring St., Los Angeles, Calif. . . . '39
Stanley, G. A. V., c/o Robison, Maxwell & Allen, "Strathkyle," Bligh St., Sydney, Australia . . . '37
‖Stanton, Edward Cramon, Box 65, Flora, Ill. . . . '41
Stanton, W. Layton, Union Oil Co. of Calif., Rm. 2, Kern Co. Land Bldg., Bakersfield, Calif. . . . '37
‖Staplin, Rex, Box 215, Mattoon, Ill. . . . '36
‖Stapp, Wilford Lee, Drilling & Expl., Inc., Box 1575, Hobbs, N. Mex. . . . '41
Stasney, H. R., consulting, Albany, Tex. . . . '26
Stauffer, Clinton R., Univ. of Minnesota, 107 Pillsbury Hall, Minneapolis, Minn. . . . '19
Stauffer, H., Lowell Ave. 544, Palo Alto, Calif. . . . '35
Stearn, Noel H., W. C. McBride, Inc., 2101 Missouri Pacific Bldg., St. Louis, Mo. . . . '29
Stebinger, Eugene, Standard Oil Co. of N. J., Prod. Dept., 30 Rockefeller Plaza, New York, N. Y. . . . '20
Steel, Robert J., c/o Steel & Black, Exchange Bldg., Eastland, Tex. . . . '31
Stehr, Raymond A., Seaboard Oil Co., 14th Floor, Continental Bldg., Dallas, Tex. . . . '28
Steig, Maynard H., Phillips Petr. Co., 521 Esperson Bldg., Houston, Tex. . . . '28
Stein, F. B., Tide Water Assoc. Oil Co., Box 1404, Houston, Tex. . . . '41
Stein, Ira H., Continental Oil Co., 604 Driscoll Bldg., Corpus Christi, Tex. . . . '23

Steinberger, Clark R., Steinberger Petr. Corp., Houston, Tex.....'28
Steinmayer, R. A., Tulane University, New Orleans, La.....'20
Steiny, Homer J., Associated Oil Co., 891 Pacific Electric Bldg., Los Angeles, Calif.....'25
Stenzel, Henryk B., Bur. of Economic Geology, Austin, Tex.....'34
Stephens, Maynard M., Ryder-Scott Co., Bradford, Pa.....'41
Stephenson, C. D., Seaboard Oil Co., Continental Bldg., Dallas, Tex.....'22
‖Stephenson, Elizabeth E., 2227–29 Commerce Bldg., Houston, Tex.....'38
Stephenson, Eugene A., Univ. of Kansas, 2 Haworth Hall, Lawrence, Kan.....'19
Stephenson, L. W., U. S. Geol. Survey, Washington, D. C.....'25
Stephenson, Morton B., Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'36
Sterrett, Douglas B., Reno Rd. & Upton St., Washington, D. C.....'25
Steubing, W. C., 513 Natl. Bank of Commerce, San Antonio, Tex.....'20
Stevens, E. H., Colorado School of Mines, Golden, Colo.....'38
Stevens, George D., independent producer, 202 Oil & Gas Bldg., Houston, Tex.....'30
‖Stevens, Nelson P., Magnolia Petr. Co., Dallas, Tex.....'42
‖Stevenson, Frank V., 2723 Lela Ave., Fort Smith, Ark.....'41
Stewart, Charles A., 804 Erie St., Shreveport, La.....'27
Stewart, Charles H., Navarro Oil Co., Box 2139, Houston, Tex.....'25
Stewart, Hugh A., The Texas Co., Denver, Colo.....'23
Stewart, Irvine E., consulting, Suite 610, 811 W. Seventh St. Bldg., Los Angeles, Calif.....'18
‖Stewart, Norman R., Turner Petr. Corp., 202 Hersee Bldg., Mt. Pleasant, Mich.....'42
Stewart, R. E., Box 745, Ventura, Calif.....'28
‖Stewart, Sam, Richfield Oil Corp., Box 470, Long Beach, Calif.....'38
Stiles, Aden E., Standard Oil Co. of Venezuela, Apt. 1329, Caracas, Venezuela, S. A.....'36
Stiles, Elisabeth, Circle S Ranch, Hamilton, Tex.....'27
Still, J. T., 3 Oak Court, Houston, Tex.....'31
*Stille, Hans, Geological Institute, Univ. of Berlin, Berlin, Germany.....'31
Stiller, Ernest A., consulting, 1509 Slattery Bldg., Shreveport, La.....'27
Stilley, Earl M., independent, 910 Staley Bldg., Wichita Falls, Tex.....'22
‖Stinear, B. H., P. O. Box 13, New Plymouth, N. Z.....'39
Stipek, Raymond J., Union Oil Co. of Calif., Los Angeles, Calif.....'29
Stipp, Thomas F., U. S. Geol. Survey, Taft, Calif.....'23
Stirtz, W. Melvin, Cities Service Oil Co., Box 1251, Bartlesville, Okla.....'28
‖Stith, Sam H., Jr., Sun Oil Co., Old Natl. Bank Bldg., Evansville, Ind.....'39
‖Stoddard, Gail H., Standard Oil Co. of Texas, Box 1249, Houston, Tex.....'40
Stoker, Carl E., Carter Oil Co., Box 801, Tulsa, Okla.....'40
Stolz, H. P., c/o Stanley & Stolz, 510 S. Spring St., Los Angeles, Calif.....'28
Stone, George Bailey, Yegua Corp., 1524 Esperson Bldg., Houston, Tex.....'40
‖Stone, R. O., 1420 S. Fifth, Alhambra, Calif.....'41
Stoner, O. E., Major Oil Co., Box 1881, Tulsa, Okla.....'22
Stoner, R. C., Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif.....'21
Stookey, D. G., The Texas Co., Box 1720, Fort Worth, Tex.....'38
Storey, Joseph B., 632 Seneca Ave., Jackson, Miss.....'39
‖Storm, Alfred E., Ned. Pac. Petr. Mij., Paleisweg 33, Medan, Sumatra, N. E. I.....'39
Storm, Lynn W., Schlumberger Well Surveying Corp., Corpus Christi, Tex.....'25
Storm, Willis, consulting, 1733 Milam Bldg., San Antonio, Tex.....'20
‖Stotler, Raymond T., Ambassador Hotel, 7 W. Fourteenth St., Tulsa, Okla.....'40
Stouder, R. E., Louisville Gas & Electric Co., 311 W. Chestnut St., Louisville, Ky.....'37
Strachan, Clyde G., Gulf Oil Corp., Box 661, Tulsa, Okla.....'29
Straley, H. W., III, Princeton, W. Va.....'35
Stratton, Everett F., Schlumberger Well Surveying Corp., Box 491, Mattoon, Ill.....'39
‖Stratton, J. L., 711 Jenkins St., Norman, Okla.....'41
‖Straughan, George M., Kentucky-West Virginia Gas Co., Prestonsburg, Ky.....'40
Stringfield, V. T., U. S. Geol. Survey, Washington, D. C.....'38
Stryker, William L., consulting, Box 9, Fredonia, Kan.....'25
Stubbs, Sidney A., Florida Geol. Survey, Box 282, Tallahassee, Fla.....'41
Stuckey, Charles W., Jr., Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'37
Stucky, Zenas E., Cities Service Oil Co., 1020 Central Bldg., Wichita, Kan.....'30
Studt, Charles W., Sagamore Oil & Gas Co., Independence, Kan.....'20
Stump, Mark E., 619½ S. Elgin Ave., Tulsa, Okla.....'35

‖Sturdevant, Rayman, Rt. 1, Box 84-A, Taft, Calif.....'40
‖Suero, Tomas, Calle 7 N, 1751, La Plata, Argentina, S. A.....'40
‖Suffield, Harry F., F. A. R. T. C., Fort Sill, Okla.....'41
Sullivan, Albert M., Carter Oil Co., Box 1490, Jackson, Miss.....'41
Sullivan, Chris Rice, Amerada Petr. Corp., Box 995, Wichita, Kan.....'36
‖Sullwold, Harold H., Jr., 332-A N. Palm Dr., Beverly Hills, Calif.....'40
Suman, John R., Humble Oil & Refg. Co., 919 Humble Bldg., Houston, Tex.....'19
‖Summerson, Charles H., 924 N. Fourth St., Springfield, Ill.....'39
Sumner, Walton, 700 Noel Dr., Longview, Tex.....'37
Sundt, O. F., Texas Gulf Prod. Co., Box 2199, Houston, Tex.....'29
‖Surber, N. Courtney, N. K. P. M., Soengei Gerong, Sumatra, N. E. I.....'39
Suter, Hans H., Geol. Dept., Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B. W. I.....'36
Sutton, A. H., Dept. of Geology, Univ. of Illinois, Urbana, Ill.....'40
Sutton, Chase E., Pure Oil Co., Box 239, Houston, Tex.....'27
Sutton, Frederick A., Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A.....'24
Suverkrop, Lew, Box 436, Bakersfield, Calif.....'27
‖Swain, Fred M., Phillips Petr. Co., Box 1729, Shreveport, La.....'42
Swayze, Ronald O., General Petr. Corp., 1033 Higgins Bldg., Los Angeles, Calif.....'36
Swesnik, Robert Malcolm, Tex Harvey Oil Co., Box 173, Palestine, Tex.....'40
Swigart, T. E., Shell Pipe Line Corp., Houston, Tex.....'20
Swiger, Rual B., consulting, Nixon Bldg., Corpus Christi, Tex.....'25

‖Taber, Edward Carroll, Jr., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'41
Tabor, Lawrence L., Richmond Petr. Co. of Colombia, Apt. Nac. 2760, Bogota, Colombia, S. A.....'28
Taegel, Edwin A., 309 Cole St., Corpus Christi, Tex.....'31
*Taff, Joseph A., 628 Cowper St., Palo Alto, Calif.....'19
Talbott, W. G., 603–4 Ellis-Singleton Bldg., Wichita, Kan.....'32
Talley, Gilbert A., Sinclair Wyoming Oil Co., Box 99, Jackson, Miss.....'38
Tandy, J. Hiram, Route 7, Tulsa, Okla.....'26
Tanner, Hugh A., The Ohio Oil Co., Box 1607, Hobbs, N. Mex.....'27
Tapp, Theodore L., Lago Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A.....'35
‖Tapper, Wilfred B., Halliburton Oil Well Cementing Co., 2301 Magnolia Bldg., Dallas, Tex.....'40
Tappolet, Werner, 5762 Tuxedo Terrace, Los Angeles, Calif.....'25
‖Tarbet, Loyal A., 330 N. Rampart, Los Angeles, Calif.....'40
Tarr, Russell S., 305 Beacon Bldg., Tulsa, Okla.....'20
Tarragona, Jose, Casilla Correo No. 1117, Buenos Aires, Argentina, S. A.....'31
Tash, George E., Shell Oil Co., Inc., Box 2099, Houston, Tex.....'36
Tasman, Cevat E., M T. A. Petrol Grubu, Direktörü, Ankara, Turkey,.....'26
‖Tator, Benjamin A., School of Geology, Baton Rouge, La.....'41
Tatum, Emmett P., Humble Oil & Refg. Co., 1065 Humble Bldg., Houston, Tex.....'29
Tatum, James L., Plymouth Oil Co., Box 598, Sinton, Tex.....'20
Taverene, N. J. M., Asiatic Petr. Co., Lensbury Club, Teddington, Middlesex, England.....'37
Taylor, Charles H., 440 Liberty Natl. Bank Bldg., Oklahoma City, Okla.....'17
Taylor, Cyril B., 877 Santos St., Abilene, Tex.....'25
Taylor, Dewitt E., 240 Eighteenth St., Bakersfield, Calif.....'28
Taylor, Garvin L., 3212 Green, Fort Worth, Tex.....'30
Taylor, George E., Continental Oil Co., 606 Division St., Evansville, Ind.....'40
Taylor, Josiah, General Geophysical Co., 2513–14 Gulf Bldg., Houston, Tex.....'36
‖Taylor, M. Hall, 701 S. Grand Ave., Lyons, Kan.....'39
Taylor, Ralph E., Box 1520, New Orleans, La.....'36
Taylor, Spence Tomlinson, Long Beach Oil Development Co., Box 199, Long Beach, Calif.....'40
‖Taylor, Surce John, University Lands, Box 1663, Midland, Tex.....'39
Taylor, W. Harlan, Petty Geophysical Eng. Co., 1449 Esperson Bldg., Houston, Tex.....'30
Teagle, John, Humble Oil & Refg. Co., R.F.D. 3, Box 370, Austin, Tex.....'31
Teague, J. U., Hogg Oil Co., 8th Floor, Great Southern Bldg., Houston, Tex.....'40
Teas, L. P., consulting, 2227 Commerce Bldg., Houston, Tex.....'21
Teas, Paul C., Ordovician Oil Co., Box 1492, Lubbock, Tex.....'22

‖Teel, Dick, 327 Parland Pl., San Antonio, Tex. . . . '40
‖Teichman, Joseph B., 210 Maple Terrace, Dallas, Tex. . . . '39
Teis, Maurice R., The Ohio Oil Co., Box 981, Tulsa, Okla. . . . '30
Templeton, James B., consulting, 1521 S. Owasso, Tulsa, Okla. . . . '25
Templeton, James Clark, Trinidad Petr. Development Co., Trinidad, B.W.I. . . . '26
Ten Eyck, Richard, Continental Oil Co., 601 W. Fifth St., Los Angeles, Calif. . . . '40
Ten Eyck, Warren E., 4041 Pacific Ave., Long Beach, Calif. . . . '32
Tennis, Langdon C., 614 W. Storey, Midland, Tex. . . . '40
Terrill, J. V., Box 1461, Midland, Tex. . . . '28
Tester, Allen C., 228 Woolf Ave., Iowa City, Iowa . . . '21
‖Teten, R. P., Phillips Petr. Co., Esperson Bldg., Houston, Tex. . . . '39
‖Thams, William H., Phillips Petr. Co., Bartlesville, Okla. . . . '41
Thom, W. T., Jr., Dept. of Geology, Princeton University, Princeton, N. J. . . . '22
‖Thomas, Clark L., 822 Thirteenth St., Golden, Colo. . . . '42
Thomas, George Dewey, Shell Oil Co., Inc., Slattery Bldg., Shreveport, La. . . . '27
‖Thomas, George T., The Ohio Oil Co., Findlay, Ohio . . . '40
Thomas, Harold S., 1910 S. Eleventh, Lincoln, Neb. . . . '32
Thomas, Horace D., Dept. of Geology, Univ. of Wyoming, Laramie, Wyo. . . . '37
Thomas, J. Elmer, 501 Rivercrest Dr., Fort Worth, Tex. . . . '17
Thomas, James W., Geophysical Service, Inc., 825 Esperson Bldg., Houston, Tex. . . . '35
‖Thomas, John W., General Delivery, Port Chicago, Calif. . . . '40
Thomas, Leonard C., Box 1270, Midland, Tex. . . . '30
Thomas, Norman L., Box 38, Bakersfield, Calif. . . . '26
‖Thomas, Ralph N., Inland Gas Corp., Ashland, Ky. . . . '38
Thomas, William A., The Ohio Oil Co., 210 Taylor Bldg., Mt. Pleasant, Mich. . . . '26
Thomas, William T., R. W. Fair Interests, Box 689, Tyler, Tex. . . . '35
Thompson, A. Beeby, 18 St., Swithins Lane, London, E. C. 4, England . . . '19
Thompson, B. E., Gulf Oil Corp., Box 1290, Fort Worth, Tex. . . . '24
Thompson, Edwin I., 1720 Johnstone, Bartlesville, Okla. . . . '31
Thompson, Evan G., consulting, 505 Gulf Bldg., Houston, Tex. . . . '29
Thompson, James D., Jr., consulting, 509½ Polk St., Amarillo, Tex. . . . '23
Thompson, John P., Amerada Petr. Corp., 1811 Esperson Bldg., Houston, Tex. . . . '34
Thompson, Lester S., 223 Forest Rd., Douglaston, Long Island, N. Y. . . . '37
Thompson, M. L., New Mexico School of Mines, Socorro, N. Mex. . . . '40
Thompson, R. R., Danciger Oil & Refiners, Inc., 1402 W. T. Waggoner Bldg., Fort Worth, Tex. . . . '20
Thompson, Sheridan A., Magnolia Petr. Co., Box 900, Dallas, Tex. . . . '23
Thompson, Wallace C., General Crude Oil Co., Box 2252, Houston, Tex. . . . '20
Thompson, Warren O., Dept. of Geology, Univ. of Colorado, Boulder, Colo. . . . '27
Thoms, Harold Wayne, New Zealand Petr. Co., Gisborne, N. Z. . . . '30
Thomsen, Erik, Stanolind Oil & Gas Co., Box 3092, Houston, Tex. . . . '39
Thomsen, Harry L., Shell Oil Co., Inc., Box 999, Bakersfield, Calif. . . . '39
Thornburg, Dwight H., General Petr. Corp., Higgins Bldg., Los Angeles, Calif. . . . '23
Thornburgh, H. R., Shell Oil Co., Inc., Los Angeles, Calif. . . . '25
Thorne, B. L., No. 56, Canada Life Bldg., Calgary, Alta., Canada . . . '30
Thrasher, Glen C., The Texas Co., Box 2100, Denver, Colo. . . . '38
‖Thurman, Franklin A., Pure Oil Co., Box 34, Roswell, N. Mex. . . . '23
‖Tichy, James R., Shell Oil Co., Inc., Box 949, Amarillo, Tex. . . . '40
Tickell, Frederick G., Dept. of Mining Engineering, Stanford University, Calif. . . . '23
Tieje, Arthur J., Apt. 408–409 Cordova Hotel, 826 W. Eighth St., Los Angeles, Calif. . . . '25
Tillotson, Allen W., consulting, 1306 Philtower Bldg., Tulsa, Okla. . . . '28
‖Timm, Bert Clifford, Magnolia Petr. Co., Box 426, Vanderbilt, Tex. . . . '42
‖Tippie, Frank E., Illinois Geol. Survey, Urbana, Ill. . . . '41
Tipsword, Howard L., Socony-Vacuum Oil Co. C.A., Apt. 246, Caracas, Venezuela, S. A. . . . '37
‖Tobin, Don Freeman, Cities Service Oil Co., 907 Milam Bldg., San Antonio, Tex. . . . '40
Todd, John D., 3633 Wickersham Lane, Houston, Tex. . . . '36
‖Todd, Oliver J., Jr., consulting, 816 American Natl. Bank Bldg., Beaumont, Tex. . . . '41
Toler, Henry N., Southern Nat. Gas Co., 804 Deposit Guaranty Bank Bldg., Jackson, Miss. . . . '26
Tollefson, E. H., Hope Nat. Gas Co., 445 W. Main St., Clarksburg, W. Va. . . . '26
Tolmachoff, I. P., Carnegie Museum, Pittsburgh, Pa. . . . '27
†Tomlinson, Charles W., producer, 509 Simpson Bldg., Ardmore, Okla. . . . '21

Tompkins, Joseph D., Acme Oil & Royalty Co., Box 1332, Midland, Tex.....'29
Tong, James A., Prod. Dept., Socony-Vacuum Oil Co., 26 Broadway, New York, N. Y.....'25
Toomey, Eugene James, Geophysical Service, Inc., 3806 Cedar Springs Rd., Dallas, Tex.....'39
Torkelson, O. I., 1509 W. Exeter St., Rt. 1, Hynes, Calif.....'37
Torrey, Paul D., The Sloan & Zook Co., 229 Shell Bldg., Houston, Tex.....'25
Totten, Robert Briggs, Geol. Dept., Phillips Petr. Co., Shreveport, La.....'38
Toulmin, Lyman, Jr., Dept. of Geology, Texas A. & M. College, College Station, Tex.....'40
Touwaide, Marcel E., Comité Natl. du Kivu, Costermansville, Belgian Congo.....'29
‖Tovell, Walter Massey, Calif. Inst. of Technology, Pasadena, Calif.....'42
Townley, Enid, Illinois Geol. Survey, Urbana, Ill.....'33
Townsend, R. M. F., Socony-Vacuum Oil Co., 26 Broadway, New York, N. Y....'27
Trager, Earl A., Washington Branch, Bell & Howell Co., 1221 G St. N.W., Washington, D. C.....'18
Trager, H. Harold, Atlantic Refg. Co., Houston, Tex.....'37
Trask, Parker D., U. S. Geol. Survey, Washington, D. C.....'26
‖Traupe, Lloyd D., The Ohio Oil Co., 1417 Milam Bldg., San Antonio, Tex.....'41
Travers, William J., Jr., Richfield Oil Corp., Box LL, Taft, Calif.....'36
Travis, Abe, 110 Midco Bldg., Tulsa, Okla.....'30
Travis, J. J., Barnsdall Oil Co., 904 Driscoll Bldg., Corpus Christi, Tex.....'39
Trenchard, John, Box 387, Evansville, Ind.....'30
‖Tribble, Margaret A., Geol. Dept., Phillips Petr. Co., Bartlesville, Okla.....'41
Triplett, Richard L., Contract Core Drilling, 2013 Westview St., Los Angeles, Calif..'28
‖Tripp, R. Maurice, 1521 East St., Golden, Colo.....'39
‖Trombla, Lynn B., Superior Oil Co., Box 96, Bakersfield, Calif.....'41
Trowbridge, Arthur C., 1182 E. Court St., Iowa City, Iowa.....'22
Trowbridge, Raymond M., consulting, 225 Owen Bldg., Tyler, Tex.....'36
Troxell, John N., The Texas Co., Box 2332, Houston, Tex.....'25
Truex, Arthur F., Sun Oil Co., Box 1348, Tulsa, Okla.....'19
Trumpy, D., Cia Shell, Apt. 114, Bogota, Colombia, S. A.....'25
Tschopp, H. I., Shell Oil Co. of Ecuador, Inc., Box 340, Quito, Ecuador, S. A.....'27
‖Tuck, Louis L., 2201 Broadway, Mt. Vernon, Ill.....'41
Tucker, Paul M., c/o H. T. Abercrombie, Barnard, Kan.....'37
Tucker, R. H., Geol. Dept., Cities Service Oil Co., Bartlesville, Okla.....'37
‖Tucker, Reagan, Bay-Tex Oil Corp., Corpus Christi, Tex.....'36
Tucker, Rietz C., W. Virginia Geol. Survey, 219 Chemistry Bldg., Morgantown, W. Va.....'21
‖Tucker, Robert L., General Geophysical Co., Little Rock, Ark.....'42
Tullis, Edward L., S. Dakota State School of Mines, Rapid City, S. Dak.....'38
‖Tuohy, John D., Standard Oil Co. of Venezuela, Caripito, Venezuela, S. A.....'40
Turman, Arthur F., Standard Oil Co. of Calif., Bin XX, Taft, Calif.....'23
‖Turnbull, Wade W., Carter Oil Co., Box 571, Eldorado, Ill.....'40
Turner, Francis Earl, Texas A. & M. College, Dept. of Geology, College Station, Tex.....'37
‖Turner, George R., The Texas Co., Box 808, Dodge City, Kan.....'41
‖Turner, Johnathan Douglas, Box 1, Kearney, Neb.....'40
Turner, Joseph H., Sinclair Prairie Oil Co., Colcord Bldg., Oklahoma City, Okla...'28
‖Tuttle, Helen F., Union Oil Co. of Calif., Los Angeles, Calif.....'41
Tuttle, R. C., Sinclair Prairie Oil Co., Box 521, Tulsa, Okla.....'42
Twenhofel, W. H., Science Hall, Univ. of Wisconsin, Madison, Wis.....'20
Tygrett, H. V., Atlantic Refg. Co., Gordon Bldg., Lake Charles, La.....'23
‖Tyler, H. Johnson, Box 488, Hugo, Okla.....'39
Tyson, Alfred K., Continental Oil Co., Box 3126, Houston, Tex.....'24

Uhrig, Leonard F. Maint. Bn., 5th A.D., Camp Cooke, Lompac, Calif.....'37
*Ulrich, E. O., National Museum, Washington, D. C.....'36
Umbach, Paul H., Stanolind Oil & Gas Co., Box 1513, Midland, Tex.....'39
Umpleby, Joseph B., consulting, 4544 Fifty-fifth Ave. N.E., Seattle, Wash.....'19
Upp, Jerry E., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'29
Upson, M. E., Gulf Oil Corp., Box 1290, Fort Worth, Tex.....'29
‖Urbom, Oscar William, 4405 Yupon St., Houston, Tex.....'39

Uren, Lester C., Hearst Mining Bldg., Univ. of California, Berkeley, Calif. . . . . '26
‖Uri, Joseph John, British-American Oil Prod. Co., Alice, Tex. . . . . '39
Ustynik, Edwin F., Box 90, Rosenberg, Tex. . . . . '38
‖Utterback, Claude, Phillips Petr. Co., 610 Ellis-Singleton Bldg., Wichita, Kan. . . . . '41
Uwatoko, Kunio, Dept. of Mining, Tokyo Imperial Univ., Tokyo, Japan . . . . . '29

Valentine, William W., Fullerton Oil Co., 1020 Security Bldg., Los Angeles, Calif. . . '30
Valerius, Claude N., 3637 Maplewood St., Dallas, Tex. . . . . '25
Valerius, M. M., Jay, Okla. . . . . '18
Vallat, Eugene H., Continental Oil Co., 601 W. Fifth St., Los Angeles, Calif. . . . . '31
Van Amringe, Edwin V., 1836 Homewood Dr., Altadena, Calif. . . . . '41
Van Beveren, O. F., Nederlandsche Pac. Petr. Mij., Paleisweg 33, Medan, Sumatra, N.E.I. . . . . '35
Van Burgh, Lisle R., 1316 Houston, Cotton Exchange Bldg., Houston, Tex. . . . . '21
Vance, Harold, Box 822, Bryan, Tex. . . . . '31
Vance, W. R., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa. . . . . '27
Van Couvering, Martin, consulting, Rm. 1009, 405 S. Hill St., Los Angeles, Calif. . . '24
Van Dall, John E., Magnolia Petr. Co., Box 1828, Oklahoma City, Okla. . . . . '22
‖Vandenberg, Frederick E., Colombian Petr. Co., Apt. 100, Cucuta, Colombia, S. A. . . . . '38
*van der Gracht, W. A. J. M., 36 Eeuwige Laan, Huize Jachtduin, Bergen, N. H., Netherlands . . . . . '17
Vander Leck, Lawrence, Box 117, Altadena, Calif. . . . . '26
van der Linden, B. H., Asiatic Petr. Corp., 8th Floor, 50 W. Fiftieth St., New York, N. Y. . . . . '19
‖Vanderpool, Eugene W., Stanolind Oil & Gas Co., Box 1540, Midland, Tex. . . . . '39
Vanderpool, Harold C., Seaboard Oil Co., Continental Bldg., Dallas, Tex. . . . . '26
Vandiver, Vincent W., Seaboard Oil Co., 417 S. Hill St., Los Angeles, Calif. . . . . '20
Van Eaton, Raymond A., Mills Bennett Prod. Co., 3402 Gulf Bldg., Houston, Tex. . . '40
Van Gilder, H. R., R.D. 4, Wellsboro, Pa. . . . . '24
†van Gogh, F. A. A., Zeekant 108 Schev., The Hague, Netherlands. . . . . '21
Van Melle, F. A., 3721 Tangley, Houston, Tex. . . . . '36
Van Orstrand, C. E., U. S. Geol. Survey, Washington, D. C. . . . . '31
Van Sant, John S., c/o J. M. Huber Corp., Box 831, Borger, Tex. . . . . '39
Van Steenbergh, S. K., Brown Geophysical Co., Box 6005, Houston, Tex. . . . . '34
‖Van Tine, Arthur B., Gulf Oil Corp., Drawer 110, Amarillo, Tex. . . . . '41
Van Tuyl, Francis M., Colorado School of Mines, Golden, Colo. . . . . '22
van Weelden, A., c/o L. K. Mower, Shell Oil Co., Inc., Box 2099, Houston, Tex. . . . . '25
Van Zant, James H., Eason Oil Co., Box 1709, Enid, Okla. . . . . '24
Vandoit, Paul L., Fifteen Oil Co., 611 West Bldg., Houston, Tex. . . . . '26
Vaughan, T. Wayland, U. S. Natl. Museum, Rm. 427, Washington, D. C. . . . . '26
‖Vaughn, Grady, Box 236, Magnolia, Ark. . . . . '41
‖Vázquez, Andrés López, Petroleos Mexicanos, Apt. 87, Coatzacoalcos, Ver., Mex. . . . . '41
Vedder, Dwight G., producer, 811 W. Seventh St., Rm. 601, Los Angeles, Calif. . . . '29
Veeder, John A., Box 896, Shawnee, Okla. . . . . '38
Vercesi, Daniel Rey, 2563 Ave. Gral. San Martin, Montevideo, Uruguay, S. A. . . . . '37
Vernon, Benton R., Mid-Continent Petr. Corp., Box 404, Shreveport, La. . . . . '38
Vernon, I. J., Coweta, Okla. . . . . '25
Vernon, Jess, Amerada Petr. Corp., Box 2040, Tulsa, Okla. . . . . '25
Vertrees, Charles D., Continental Oil Co., Box 431, Midland, Tex. . . . . '24
Ver Wiebe, Walter A., Geol. Dept., Univ. of Wichita, Wichita, Kan. . . . . '19
Vesely, Leon R., Amerada Petr. Corp., 1811 Esperson Bldg., Houston, Tex. . . . . '38
Vetter, John M., Pan-American Prod. Co., 1245 Mellie Esperson Bldg., Houston, Tex. . . . . '24
Vickery, Ward R., Vernon Oil & Gas Co., Wichita, Kan. . . . . '28
‖Vieaux, Don G., Union Prod. Co., 841 M & M Bldg., Houston, Tex. . . . . '40
‖Vincent, Mordelo L., Jr., Box 103, Lake Charles, La. . . . . '38
Vitt, Alfred W., Seaboard Oil Co. of Delaware, 417 S. Hill St., Los Angeles, Calif. . . '37
Voigt, Harold E., Shasta Oil Co., Corpus Christi, Tex. . . . . '36
Voitesti, Ion Popescu, Laboratorul de Geologie, Universitatea, Bucuresti, Roumania . . . . . '26
Vonderschmitt, Louis, Geolog.-Pal. Institut, Bernoullianum, Basle, Switzerland . . . . '39

‖Von Eiff, Herbert C. W., c/o W. R. Davis, Inc., Commerce Bldg., Houston, Tex..'40
von Estorff, F., Socony-Vacuum Oil Co., Inc., Rm. 1700, 26 Broadway, New York, N. Y.....'30
‖Von Osinski, William, Klaus Expl. Co., Box 1617, Lubbock, Tex.....'39

‖Waddell, Richard Kent, Boeing Airplane Co., Wichita, Kan.....'41
Wade, Arthur, Shell Co., Shell House, Ann St., Brisbane, Queensland, Australia...'27
Wade, R. T., Schlumberger Well Surveying Corp., Box 71, Winnfield, La.....'36
‖Wade, Wallace Lee, Geol. Dept., Humble Oil & Refg. Co., Houston, Tex.....'41
‖Wadsack, George E., Jr., 701 Hamilton Bldg., Wichita Falls, Tex.....'40
‖Wadsworth, A. H., The Texas Co., Box 1270, Midland, Tex.....'41
‖Wadsworth, F. Lowry, General Petr. Corp., 6 Crites Bldg., Bakersfield, Calif.....'37
Wagener, Charles H., 842 Milam Bldg., San Antonio, Tex.....'20
Waggoner, Stephen Gose, consulting, 204 First Natl. Bank Bldg., Wichita Falls, Tex.'29
Wagner, Carl D., consulting, 2259 S. Troost, Tulsa, Okla.....'39
Wagner, Carroll M., General Petr. Corp., 1003 Higgins Bldg., Los Angeles, Calif...'20
‖Wagner, C. Richard, Jr., Pure Oil Co., Box 2127, Amarillo, Tex.....'40
Wagner, Clyde L., consulting, 2258 S. Troost, Tulsa, Okla.....'27
Wagner, J. Basil, consulting, Box 37, Chandler, Okla.....'27
Wagoner, George E., Carter Oil Co., Box 801, Tulsa, Okla.....'28
Wahlstrom, Edwin A., Goldsmith Pool Eng. Committee, Box 1801, Midland, Tex.'27
Wails, Elmer D., Midstates Oil Corp., 518 Natl. Bank of Tulsa Bldg., Tulsa, Okla...'31
Waite, S. T., United British Oilfields of Trinidad, Point Fortin, Trinidad, B.W.I...'41
‖Walcher, Wayne E., Gulf Refg. Co., Mattoon, Ill.....'40
Waldschmidt, W. A., Colorado School of Mines, Golden, Colo.....'26
Walker, Jules Hargis, Superior Oil Corp., 1109 Commerce Bldg., Houston, Tex....'36
Walker, Lucian H., consulting, 1635 E. Fourteenth St., Tulsa, Okla.....'20
Walker, W. L., Richfield Oil Corp., Los Angeles, Calif.....'18
Wall, Earle R., 32 Neron Pl., New Orleans, La.....'29
Wall, Thomas E., Natl. Petroleum & Southwestern Royalty Cos., Mt. Vernon, Ill.....'30
Wallace, Davis M., consulting, 609 Esperson Bldg., Houston, Tex.....'27
Wallace, Louis S., Superior Oil Co., Box 510, Midland, Tex.....'40
Wallace, P. A., Amerada Petr. Corp., Box 896, Shawnee, Okla.....'36
Wallace, William Edwin, Jr., Centenary College, Shreveport, La.....'39
Wallis, William E., West India Oil Co., Apt. XXIII, San Jose, Costa Rica.....'30
Walpole, Leonard W., Shell Co. of Australia, Ltd., Ann St., Brisbane, Queensland, Australia.....'41
Walter, H. G., The Ohio Oil Co., Findlay, Ohio.....'37
Walter, Karl L., 1598 Monroe St., Denver, Colo.....'29
Walters, Mason G., North Penn Gas Co., Port Allegany, Pa.....'28
Walters, Ray P., Rm. 2150, 30 Rockefeller Plaza, New York, N. Y.....'20
Waltman, W. D., 601 Edison Bldg., Fifth at Grand, Los Angeles, Calif.....'29
‖Walton, George G., Carter Oil Co., Drawer 1739, Shreveport, La.....'38
Walton, O. E., Atlantic Refg. Co., 8th Floor, Magnolia Bldg., Dallas, Tex.....'30
Wanenmacher, Joseph M., Shell Oil Co., Inc., Box 2009, Wichita Falls, Tex.....'27
Wanless, Harold R., 126 Natural History Bldg., Urbana, Ill.....'32
Wantland, Dart, Colorado School of Mines, Golden, Colo.....'31
Ward, C. J., Shell Oil Co., Inc., Box 1509, Midland, Tex.....'34
‖Ward, Dwight E., International Petr. Co., Box 803, Guayaquil, Ecuador, S. A...'39
Ward, Freeman, Lafayette College, Easton, Pa.....'30
‖Ward, Harold E., Forest Development Corp., 1229 Milam Bldg., San Antonio, Tex.'39
Ward, Roderick C., Superior Oil Co., Oil & Gas Bldg., Houston, Tex.....'35
‖Ward, Roland V., Shell Oil Co., Inc., 1009 Central Bldg., Wichita, Kan.....'41
Waring, Gerald A., U. S. Geol. Survey, Washington, D. C.....'23
Waring, W. W., International Petr. Co., Casilla 803, Guayaquil, Ecuador, S. A....'29
Warne, Archer H., Richfield Oil Corp., 560 Haberfelde Bldg., Bakersfield, Calif.....'39
Warner, Charles A., Houston Oil Co., Box 2412, Houston, Tex.....'19
Warner, J. Laird, consulting, 248 N. Depot Rd., McAllen, Tex.....'30
Warner, Ralph E., 132 W. Mariposa Dr., San Antonio, Tex.....'31
Warren, Howard C., 1907 Esperson Bldg., Houston, Tex.....'28
Warren, John Edwin, c/o Carl B. King Drilling Co., Box 270, Midland, Tex.....'37
Warthin, Aldred S., Jr., Geol. Dept., Vassar College, Poughkeepsie, N. Y.....'28

‖Wasem, Richard, School of Geology, Baton Rouge, La.....'41
Washburne, Chester W., Rm. 2603, 149 Broadway, New York, N. Y.....'18
‖Wasserfallen, Bernard, Chambrelien, Neuchatel, Switzerland.....'34
Wasson, Harold J., 25 Broadway, New York, N. Y.....'27
Wasson, Theron, Pure Oil Co., Rm. 2308, 35 E. Wacker Dr., Chicago, Ill.....'20
Waterfall, Louis N., Union Oil Co. of Calif., 1100 Union Oil Bldg., Los Angeles, Calif.'24
Waters, A. C., Box 1738, Stanford University, Calif.....'37
Waters, James A., Sun Oil Co., Box 2880, Dallas, Tex.....'25
‖Waters, Joyce Irene, Schlumberger Well Surveying Corp., Box 2175, Houston, Tex.'41
Watson, C. P., Seaboard Oil Co., Rm. 970, 417 S. Hill St., Los Angeles, Calif.....'25
‖Watson, Elizabeth A., Expl. Dept., Union Oil Co. of Calif., 617 W. Seventh St., Los Angeles, Calif.....'42
Watson, George R., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa.....'36
Watson, Joseph D., consulting, 720 World Bldg., Tulsa, Okla.....'21
‖Watson, Robert N., Atlantic Refg. Co., Box 895, Lake Charles, La.....'38
Weatherby, B. B., Geophysical Research Corp., Box 2040, Tulsa, Okla.....'30
Weatherston, Douglas, Standard Oil Co. of Texas, Box 1249, Houston, Tex.....'30
Weaver, Charles E., Dept. of Geology, Univ. of Washington, Seattle, Wash.....'34
Weaver, George A., 2339 W. Rosedale, Fort Worth, Tex.....'26
Weaver, Paul, Gulf Oil Corp., Drawer 2100, Houston, Tex.....'20
‖Webb, James A., Box 407, Mt. Pleasant, Tex.....'30
Webb, Rieman S., independent, 510 Bitting Bldg., Wichita, Kan.....'37
Weedle, Herman W., Standard Oil Co. of Calif., Box 1200, Bakersfield, Calif.....'29
Weeks, Albert W., Box 1536, University Station, Austin, Tex.....'27
Weeks, Herbert J., Sun Oil Co., 1608 Walnut St., Philadelphia, Pa.....'24
Weeks, Lewis G., Standard Oil Co. of N. J., Rm. 2150, 30 Rockefeller Plaza, New York, N. Y.....'24
Weeks, Warren B., Phillips Petr. Co., Box 1729, Shreveport, La.....'29
Wegemann, Carroll H., National Park Service, 332 Keeline Bldg., Omaha, Neb....'20
‖Weidemann, Carl, Box A-185, Port-au-Prince, Haiti.....'31
Weimer, Frank G., consulting, 411 Ritz Bldg., Tulsa, Okla.....'37
Weingartner, R. A., Stanolind Oil & Gas Co., Box 3092, Houston, Tex.....'37
Weintz, Clement A., Stanolind Oil & Gas Co., Box 1092, Shreveport, La.....'27
Weinzierl, John F., consulting, Lauratal, Riverside, Walker County, Tex.....'22
Weirich, T. E., Phillips Petr. Co., Bartlesville, Okla.....'21
Weisbord, Norman E., N.K.P.M., Soengei Gerong, Palembang, Sumatra, N. E. I...'25
Welch, Virgil H., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'27
Weller, J. Marvin, Illinois Geol. Survey, Urbana, Ill.....'29
Wellings, F. E., Iraq Petr. Co., Ltd., Katamon, Jerusalem, Palestine.....'24
Wellman, Dean C., Pure Oil Co., Box 271, Tulsa, Okla.....'37
‖Wells, H. P., Jr., Houston Oil Co. of Texas, Box 2412, Houston, Tex.....'42
Wells, Murray J., Cities Service Oil Co., Box 1251, Bartlesville, Okla.....'39
Wells, Samuel W., Ashland Oil & Refg. Co., 623 Market St., Mt. Carmel, Ill.....'19
Welsh, Leroy G., 707 Natl. Standard Bldg., Houston, Tex.....'19
‖Weltman, Louis H., 247 Wall St., Shreveport, La.....'41
‖Wenberg, Edwin Hugo, Seismograph Service Corp., Kennedy Bldg., Tulsa, Okla.'41
Wendenburg, Otto, Box 536, Marksville, La.....'40
Wender, W. G., Normandie Oil Co., 1907 Commerce Bldg., Houston, Tex.....'26
Wendlandt, E. A. Humble Oil & Refg. Co., Box 2025, Tyler, Tex.....'24
Wesley, George R., Skelly Oil Co., Evansville, Ind.....'35
West, Donald M., Socony-Vacuum Oil Co. C.A., Apt. 246, Caracas, Venezuela, S. A.'41
West, Lloyd G., Seaboard Oil Co., 506 Driscoll Bldg., Corpus Christi, Tex.....'39
West, W. W., Skelly Oil Co., Box 993, Midland, Tex.....'35
Westby, Gerald H., Seismograph Service Corp., 709 Kennedy Bldg., Tulsa, Okla...'23
Westheimer, Jerome M., Simpson-Fell Oil Co., Ardmore, Okla.....'32
‖Westmoreland, Earl, Seaboard Oil Co., Box 238, Evansville, Ind.....'40
Westmoreland, Frank S., consulting, 906 Sterling Bldg., Houston, Tex.....'34
‖Wethington, W. O., Nash, Okla.....'30
Weymouth, A. Allen, New Zealand Petr. Co., Ltd., Box 295, Gisborne, N. Z.....'29
Wharton, J. B., Jr., consulting, Box 175, Lafayette, La.....'41
‖Whatley, James M., Union Sulphur Co., Sulphur, La.....'40
Whealton, Rowland G., M. O. Johnston Oil Tools, Inc., Los Angeles, Calif.....'25
Wheeler, H. A., consulting, Security Bldg., St. Louis, Mo.....'27

Wheeler, Orby Clinton, International Petr. Co., 56 Church St., Toronto 2, Ont., Canada ..... '26
Wheeler, Russell B., Texas Petr. Co., Apt. 877, Bogota, Colombia, S. A. ..... '37
Whetsel, R. V., 60 Wall St., New York, N. Y. ..... '37
Whipple, G. Leslie, Apt. Nac. 2760, Bogota, Colombia, S. A. ..... '36
Whisenant, J. Barney, c/o Whisenant & Trenchard, Box 387, Evansville, Ind. ..... '25
Whitaker, Harvey, Gorman-Yoakam Drilling Co., 1105 Milam Bldg., San Antonio, Tex. ..... '31
Whitcomb, Bruce, Box 106, Groesbeck, Tex. ..... '24
‖White, Albert William, Fain-McGaha Oil Corp., 607 Hamilton Bldg., Wichita Falls, Tex. ..... '42
White, Dan J., Salt Dome Oil Corp., Houston, Tex. ..... '38
White, Gordon H., Expl. Dept., Shell Oil Co., Inc., Box 2099, Houston, Tex. ..... '29
‖White, James G., Geol. Dept., Humble Oil & Refg. Co., Houston, Tex. ..... '39
White, Kessack D., Standard Oil Co. of Egypt, 22 Sharia Kasr el Nil, Cairo, Egypt '22
White, Kirk S., 945 Kennedy Bldg., Tulsa, Okla. ..... '35
White, Luther H., 914 Palace Bldg., Tulsa, Okla. ..... '20
White, Maynard P., Gulf Oil Corp., Box 30, Ardmore, Okla. ..... '25
‖White, Paul C., Federal Power Commission, Eighteenth & K St. Annex, Washington, D. C. ..... '40
White, Rex H., Magnolia Petr. Co., 721 Browder St., Dallas, Tex. ..... '38
‖White, Richard D., The California Co., New Orleans, La. ..... '37
White, Robert T., Barnsdall Oil Co., Bakersfield, Calif. ..... '38
White, Tell T., Securities & Exchange Commission, Eighteenth & Locust Sts., Philadelphia, Pa. ..... '39
Whitehead, W. L., 222 Charles River Rd., Cambridge, Mass. ..... '29
Whiting, Lester L., The Texas Co., 708 Hightower Bldg., Oklahoma City, Okla. ..... '38
‖Whitlock, R. A., Jr., 2117 Melrose, Rockford, Ill. ..... '40
Whitney, F. L., 2715 Splitrock Ave., Austin, Tex. ..... '20
Whitney, Paul A., General Geophysical Co., Box 187, Mt. Vernon, Ill. ..... '24
Whitney, Paul B., Box 133, Grand Rapids, Mich. ..... '23
Whiton, Herman F., Union Sulphur Co., 33 Rector St., New York, N. Y. ..... '41
Whittier, William H., Box 1166, Salt Lake City, Utah ..... '24
‖Whittinghill, F. T., Jr., 507 W. Main St., Robinson, Ill. ..... '39
Whitwell, E. V., Oliphant Oil Corp., Commercial Bank Bldg., Shreveport, La. ..... '19
Whortan, Raymond A., consulting, c/o Lerke & Whortan, 423 Union Natl. Bank Bldg., Wichita, Kan. ..... '35
Whorton, Chester D., Box 311, Coudersport, Pa. ..... '29
Wiedenmayer, Carl, Societa Petrolifera Italiana, Fornovo-Taro, Parma, Italy ..... '26
Wiegand, F. W., 1206 Magnolia St., Lockhart, Tex. ..... '36
‖Wilbert, Louis J., Jr., 406 Church St., Plaquemine, La. ..... '40
Wilcox, Fred H., Magnolia Petr. Co., Box 633, Midland, Tex. ..... '29
Wilcox, Stanley W., Seismograph Service Corp., 709 Kennedy Bldg., Tulsa, Okla. ..... '40
Wilder, Newell M., Petroleum Exploration, Inc., Lexington, Ky. ..... '38
Wilhelm, Arthur K., 704 Empire Masonic Bldg., Bartlesville, Okla. ..... '28
Wilhelm, Oscar G., Shell Oil Co., Inc., Box 2099, Houston, Tex. ..... '41
Williams, Carroll L., Humble Oil & Refg. Co., Box 1331, Kingsville, Tex. ..... '37
Williams, Charles C., National Geophysical Co., 1002 Tower Petroleum Bldg., Dallas, Tex. ..... '40
Williams, Francis S., consulting, 423 S. Maple, McPherson, Kan. ..... '24
Williams, George C., consulting, 1843 W. Forty-seventh St., Los Angeles, Calif. ..... '27
Williams, Herbert E., 533 Oil & Gas Bldg., Houston, Tex. ..... '26
Williams, J. Stewart, Utah State Agricultural College, Dept. of Geology, Logan, Utah ..... '37
Williams, John R., The Texas Co., Box 1737, Shreveport, La. ..... '37
‖Williams, Lou, Pure Oil Co., Rm. 2308, 35 E. Wacker Dr., Chicago, Ill. ..... '41
‖Williams, Philip A., Carter Oil Co., Box 150, Magnolia, Ark. ..... '41
‖Williams, Robert N., Honolulu Oil Corp., Rm. 19, Kern Co. Land Bldg., Bakersfield, Calif. ..... '38
Williams, Thomas B., consulting, 3406 Sixth St., West, Calgary, Alta., Canada ..... '30
Williams, W. A., Box 265, Capitola, Calif. ..... '19
Williamson, Harry, Arkansas Fuel Oil Co., 1452 Canal St., New Orleans, La. ..... '37
Williamson, Thomas F., Victoria Cottage, Pittenweem Fife, Scotland ..... '32

‖Willis, Clifford L., Carter Oil Co., Box 206, Jena, La.....'40
Willis, Cornelius G., 1135 Subway Terminal Bldg., 417 S. Hill St., Los Angeles, Calif.....'25
Willis, Robin, Hilldon Oil Co., 1135 Subway Terminal Bldg., Los Angeles, Calif.....'27
Willis, S. Morse, Carter Oil Co., Box 801, Tulsa, Okla.....'24
Williston, Samuel H., 909 Studio Bldg., Portland, Ore.....'24
Wills, Neil H., consulting, Box 529, Carlsbad, N. Mex.....'34
Willson, Kenneth M., 705 Union Bank Bldg., Wichita, Kan.....'29
Wilshire, L. M., Skelly Oil Co., Box 1650, Tulsa, Okla.....'23
‖Wilson, Arthur Noble, 936 Woodland Ave., Houston, Tex.....'40
Wilson, Cedric Clarke, Trinidad Petr. Dev. Co., Ltd., Palo Seco, Trinidad, B.W.I.'40
Wilson, Charles W., Jr., Vanderbilt Univ., Nashville, Tenn.....'38
Wilson, Edward B., Sun Oil Co., Tyler, Tex.....'22
‖Wilson, Ernest B., Hogg Oil Co., Great Southern Bldg., Houston, Tex.....'41
‖Wilson, E. E., Geotechnical Corp., 1702 Tower Petroleum Bldg., Dallas, Tex....'40
Wilson, Forest Wayne, Republic Prod. Co., 1813 Petroleum Bldg., Houston, Tex...'40
Wilson, Homer M., consulting, Box 250, Marathon, Tex.....'27
‖Wilson, Ivan F., 715 Lindsey St., Norman, Okla.....'41
‖Wilson, James, Jr., Shell Oil Co., Inc., 2000 Alamo Natl. Bldg., San Antonio, Tex.'40
Wilson, Joe G., Texas Petr. Co., Apt. 877, Bogota, Colombia, S. A.....'31
Wilson, John H., 2015 Fort Worth Natl. Bank Bldg., Fort Worth, Tex.....'21
Wilson, Joseph M., 6235 Richmond Ave., Dallas, Tex.....'22
Wilson, Malcolm E., General American Oil Co., Dallas, Tex.....'20
Wilson, Richard M., The Ohio Oil Co., Box 1129, Shreveport, La.....'38
Wilson, Thomas C., Venezuelan Atlantic Refg. Co., Apt. 968, Caracas, Venezuela, S. A.....'30
Wilson, Walter B., Gulf Oil Corp., Box 661, Tulsa, Okla.....'21
Wimbish, Forrest E., Magnolia Petr. Co., Box 1882, Wichita, Kan.....'28
Wines, Donald Bradford, Central Petr. Co., Inc., Wichita, Kan.....'29
Winfrey, Donald B., Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex....'31
Winham, W. P., Standard Oil Co. of Calif., Box 1200, Bakersfiled, Calif.....'28
Winkler, B. O., c/o N.K.P.M., Palembang, Sumatra, N.E.I.....'31
Winkler, Hans, Sun Oil Co., Austin, Tex.....'31
‖Winkler, Virgil, Geology Laboratory, Standard Oil Co. of Venezuela, Caripito, Venezuela, S. A.....'40
Winter, Niles B., Atlantic Refg. Co., Box 871, Midland, Tex.....'24
Winterer, Edward V., Superior Oil Co., 930 Edison Bldg., Los Angeles, Calif.....'27
Winton, Will M., Texas Christian University, Fort Worth, Tex.....'20
Winzeler, Alvin R., Stanolind Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan.....'40
Wiringa, Leon O., Shell Oil Co., Inc., 2000 Alamo Natl. Bldg., San Antonio, Tex...'37
Wissler, Stanley G., Union Oil Co. of Calif., Box 511, Compton, Calif.....'27
‖Witherspoon, Edgar, 423 S. Highland, Ada, Okla.....'40
Wofford, H. R., Jr., 234 W. Mistletoe, San Antonio, Tex.....'35
‖Wold, John S., 1028 Connecticut Ave., Washington, D. C.....'41
Wolf, Albert G., Texas Gulf Sulphur Co., 1009 Second Natl. Bank Bldg., Houston, Tex.....'24
Wolters, Earl M., 3332 Columbine St., Denver, Colo.....'30
‖Wolverton, Harold A., Halliburton Oil Well Cementing Co., Box 271, Lake Charles, La.....'41
Womack, Brame, Southern Prod. Co., 803 Deposit Guaranty Bldg., Jackson, Miss.'34
Wood, Fred E., Standard Oil Co. (Indiana), 910 S. Michigan Ave., Chicago, Ill....'24
Wood, George R., Texas Petr. Co., Apt. Nac. 877, Bogota, Colombia, S. A.....'30
Wood, James T., Jr., The Texas Co., 929 S. Broadway, Los Angeles, Calif.....'24
Wood, J. Pendleton, Yreka Inn, Yreka, Calif.....'27
Wood, Robert H., Broswood Oil Co., 430 Beacon Bldg., Tulsa, Okla.....'20
Wood, Virgil O., Broswood Oil Co., 430 Beacon Bldg., Tulsa, Okla.....'20
Woodford, Alfred O., Pomona College, Claremont, Calif.....'24
Woods, E. Hazen, 2003 W. Brunson, Midland, Tex.....'25
Woods, R. D., Humble Oil & Refg. Co., 1065 Humble Bldg., Houston, Tex.....'35
Woods, Sam H., Sun Oil Co., Box 1348, Tulsa, Okla.....'25
Woodward, Albert F., Box 67, Whittier, Calif.....'38
Woodward, George E., Jr., 2112 N. W. Twenty-fifth St., Oklahoma City, Okla....'29

Woodward, Harold Robinson, 930 N. Holyoke Ave., Wichita, Kan.....'25
‖Woodward, W. T., consulting, Security Bldg., Taft, Calif.....'38
Woolley, Glen C., Transwestern Oil Co., Wichita, Kan.....'28
*Woolnough, W. G., "Callabonna," 8 Park Ave., Gordon, N. S. W., Australia....'29
Woolsey, E. V., consulting, Box 268, Luling, Tex.....'20
Word, Charles F., Box 1821, Midland, Tex.....'38
Workman, L. E., Illinois Geol. Survey, Natural Resources Bldg., Urbana, Ill.....'40
Wosk, L. David, 1009 Subway Terminal Bldg., 417 S. Hill St., Los Angeles, Calif...'24
Wrather, W. E., consulting, 4300 Overhill Dr., Dallas, Tex.....'17
Wright, Andrew C., 524 Woldert St., Tyler, Tex.....'20
Wright, Fay Linton, consulting, 526½ N. Orange St., Glendale, Calif.....'27
Wright, Fred S., Box 1151, Midland, Tex.....'20
Wright, Harry F., 304 Philtower Bldg., Tulsa, Okla.....'19
Wright, Hugh, Texas Gulf Sulphur Co., 1009 Second Natl. Bank Bldg., Houston, Tex.....'30
Wright, Randall, U. S. Engineer Office, M & M Bldg., Houston, Tex.....'35
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Fidlar, M. M.
Galloway, J. J.
Spencer, Charles G.

EVANSVILLE
Barbour, Richard Morton
Bodkin, Hillard W.
Bybee, Halbert Homer
Cahill, Edgar D.
Caylor, Garth W.
Cole, Edwin G.
Combs, Edward J.
Cooper, Russell C.
Davies, Nathan C.
Eberhardt, A. T.
Eberle, Robert F.
Edwards, Hall
Elder, Stanley G.
Engel, Noel W.
Falletti, A. D.
Farrand, William Gardner
Forsyth, Roderick
Gow, Kenneth L.
Hand, H. D.
Hard, Edward W.
Hicklin, Richard S.
Hoke, Charles J.
Honess, Charles W.
Hoover, W. Farrin
Horton, Harold M.
Keeler, William W.
McEachin, W. D.
McNeal, Robert P.
Nowlan, Harry H.
Osborne, Paul F.
Otton, Edmond George, III
Reeves, James E.
Rogers, Maynard
Sackett, H. F.
Snider, George W.
Stith, Sam H., Jr.
Taylor, George E.
Trenchard, John
Wesley, George R.
Westmoreland, Earl
Whisenant, J. Barney

FARMERSBURG—Heap, George E.

FORT WAYNE
Parker, Norbert A.

GOSHEN—Clark, Charles K.

GREENCASTLE—Clair, Joseph R.
Smith, Ernest Rice

INDIANAPOLIS—Brooks, Frank M.
Hake, Benjamin F.
Ingham, W. I.
Ketterer, Walter P.
Longmire, William R.
Scobey, Ellis H.

MONTICELLO
Baer, Daurice Frank

REDKEY—Rosenkrans, R. R.

RENSSELAER—Fanshawe, John R.

ROCHESTER—KONKEL, Philip M.

SOUTH BEND—Smith, Knowles B.

VINCENNES—Mundorf, T. Dean
Sprowls, Harlan A.

IOWA

AMES—Lonsdale, John T.

BURLINGTON
Smith, Marcus A. J.

IOWA CITY—Miller, Arthur K.
Tester, Allen C.
Trowbridge, Arthur C.

MT. VERNON
Bennett, Robert Turner

KANSAS

BARNARD—Tucker, Paul M.

CHASE—Price, Arthur S.

DODGE CITY—Turner, George R.

ELDORADO—Berry, George F., Jr.

FREDONIA—Stryker, William L.

GARDEN CITY
Hubley, Myron D.

GREAT BEND
Brooks, Benton S., Jr.
Denman, C. E.
Gutru, Robert J.
Knight, L. Clark
McCullough, R. L.
McDaniel, Fred I.
Prescott, Gordon W.
Shannon, Sherril A.

HAYS—Messman, Roger L.

INDEPENDENCE
Studt, Charles W.

LAWRENCE
Bowsher, Arthur Leroy
Jakosky, J. J.
Jones, Ogden S.
Laudon, Lowell R.
Lee, Wallace
Moore, Raymond C.
Payne, Thomas G.
Stephenson, Eugene A.

LYONS—Taylor, M. Hall

MCPHERSON
Williams, Francis S.

NEODESHA—Ashley, Richard M.

PITTSBURG—Abernathy, G. E.

RUSSELL—Brazil, James J.
Cooper, James Blair

SEDAN—Disney, Orville A.

TOPEKA—Allen, Devere F.

WELLINGTON
Matthews, Charles L.
Matthews, Edwin P.

WICHITA—Agey, Charles S.
Ainsworth, David
Allan, Thomas H.
Allen, Donald M.
Ashley, Burton E.
Baldwin, Ben F.
Barwick, John S.
Baughman, George W.
Bear, Melvern F.
Beebe, B. W.
Boreing, M. J.
Bowser, William F.
Bradley, Everett L.
Bruce, George H.
Buck, Loren I.
Bunte, Arnold S.
Butcher, S. D.
Carlson, Edwin N.
Carmody, Robert A.
Carpenter, E. Gail
Clark, Robert S.
Cole, Virgil B.
Conselman, Frank B.
Copass, Jack M.
Cornell, Lee H.
Costa, Delbert J.
Daniels, James I.
Downing, R. B.
Dunn, Burton C.
Edmiston, E. K.
Elledge, E. R.
Fisher, Frank L.
Folger, Anthony
Fortier, Leo R.
Galley, John E.
Galloway, George Harold
Garlough, J. L.
George, Robert Freeman
Gisburne, John Robert
Hall, Roy H.
Hay, Lawrence
Heathman, Jack H.
Heathman, Walter W.
Holl, F. G.
Holmes, F. G.
Holmes, S. W.
Howell, W. F.
Imbt, William C.

Inkster, John W.
Isaacs, Elizabeth
Jager, Eric H.
Johnston, Robert L.
Kesler, L. W.
Koester, Edward A.
Kornfeld, Sam
Lamb, R. C.
Lapp, John H.
Larkin, J. J., Jr.
Larsh, Walter W.
Larson, Carl L., Jr.
Lee, Marvin
Lillibridge, Fred S.
McClellan, Hugh W.
McHugh, W. E.
McMurtry, Wilbur Earl
McNeely, Robert B.
McNeil, Harold E.
Mettner, Francis E.
Meyer, Robert F.
Michaelson, Louis H.
Moncrief, E. C.
Moody, Ray R.
Morgan, L. C.
Morrill, Junius H.
Mull, J. A., Jr.
Oyster, Frank A.
Paddleford, Jack T.
Page, James H.
Peters, T. C.
Philbrick, E. P.
Powers, Delmer L.
Pratt, Ernest S.
Putnam, George D.
Redmon, Harold E.
Reiserer, Victor F.
Roberts, Thomas N.
Roop, Charles W.
Russell, Harry J., Jr.
Sammons, George B.
Schuldt, Walter C.
Selk, Erwin L.
Smedley, Harold O.
Smith, J. Peter
Smith, Millard Wesley
Speer, George W.
Stafford, Clare J.
Stucky, Zenas E.
Sullivan, Chris Rice
Talbott, W. G.
Utterback, Claude
Ver Wiebe, Walter A.
Vickery, Ward R.
Waddell, Richard Kent
Ward, Roland V.
Webb, Rieman S.
Whortan, Raymond A.
Willson, Kenneth M.
Wimbish, Forrest E.
Wines, Donald Bradford
Winzeler, Alvin R.
Woodward, Harold Robinson
Woolley, Glen C.
Wright, T. G.

WINFIELD—Bailey, Joe E. L.

KENTUCKY

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Hunter, Coleman D.
Thomas, Ralph N.

BOWLING GREEN
McCoy, Alex W., III
Newton, William A.

GLASGOW—Preston, J. Basil

LEXINGTON—Branson, Carl C.
Freeman, Louis Barton
Jones, Daniel J.
McFarlan, Arthur C.
Wilder, Newell M.

LOUISVILLE—Stouder, R. E.

OWENSBORO—Brown, J. Albert
Damron, Wallace
Knipe, R. E.
Shiarella, Nicholas W.

PRESTONSBURG
Straughan, George M.

LOUISIANA

ALEXANDRIA
Kaplan, Lazard Harold
Richardson, Felix D.

BASTROP—Stanley, Ben, Jr.

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Bell, Harry Wesley
Dunbar, Clarence P.
Fisk, Harold N.
Gay, Andrew H.
Hadley, Wade H., Jr.
Howe, Henry V.
Huner, John, Jr.
Jones, Paul Hastings
LeRoy, Tom E.
Lock, John Henry
Maher, John C.
Martin, James L., Jr.
McGuirt, James H.
Monsour, Edward
Romans, William A.
Roy, Chalmer J.
Russell, R. Dana
Russell, Richard Joel
Shay, D. C.
Smith, R. Hendee
Sprague, Robert D.
Tator, Benjamin A.
Wasem, Richard

BURAS—Eskrigge, Tatham R.

CAMP LIVINGSTON
Lester, John L.

CROWLEY
Gueno, Albert Jules, Jr.
Patton, Jacob L.

DE RIDDER
Granberry, Raymond J.
Iles, George, Jr.

ELIZABETHTOWN
McClure, Perry S.

FERRIDAY—Goebel, Lawrence A.

GOOD PINE—Howard, Douglas D.

GRETNA—Kipp, E. M.

HOMER—Metcalf, Myron C.

HOUMA—Babin, Logan H.
Bolyard, Garrett L.
Broughton, M. N.
Fanguy, Nolan A.
Janovy, John
Ronbeck, Arthur C.

JEANERETTE
Robichaux, Douglas B.

JENA—Holden, Frederick T.
McBee, William Dalton
Philpott, Thomas Hughes
Willis, Clifford L.

LAFAYETTE—Bates, Fred W.
Bernard, Hugh Allen
Bingham, D. H.
Bornhauser, Max
Fry, Earl E.
Miller, Albert Douglas
Mills, Coe S.
Orchard, Paul Joseph
Pennel, H. David
Sands, Charles D.
Wharton, J. B., Jr.

LAKE CHARLES
Baysinger, Eugene M.
Canada, W. R.
Johnson, Holger Olin
Mahoney, J. F.
McGlasson, H. E.
Morrow, A. L.
Roach, C. B.
Tygrett, H. V.
Vincent, Mordelo L., Jr.
Watson, Robert N.
Wolverton, Harold A.

MARKSVILLE—Brockway, E. R.
Wendenburg, Otto

MONROE—Fergus, Preston
McAuliffe, G. C.

MORGAN CITY—Fouts, J. M.

NATCHITOCHES—Manes, O. B.

NEW IBERIA
Calahan, Luther Weldon
Ferrero, Clarence
Sparenberg, G. R.

NEW ORLEANS
Atwater, Gordon I.
Blackwell, William G.
Bremer, Bernhard E.
Bybee, Robert William
Carsey, J. Ben
Clark, George H.
Clement, George M.
Copeland, Robert R., Jr.
Crandall, Kenneth H.
Davies, Herman F.
Dobrick, Edward G.
Goerner, Fred S.
Goodwill, Donald, Jr.
Helis, James
Hickey, Harold N.
Hoover, J. W.
Kilbourne, Lewis P.
Kinser, J. H.
Loeblich, Helen Tappan
Lund, Gage V.
Metts, Dean F.
Moresi, Cyril K.
Nichols, E. T.
Payne, Willard M.
Petersen, Harluf C.
Petersen, M. Q.
Richardson, H. T.
Samford, Finis Mack
Schall, Fred M., Jr.
Schneider, G. W.
Seals, Wilburn Hall
Seashore, Paul T.
Seedle, Charles W.
Shepherd, G. Frederick
Smith, Neal J.
Steinmayer, R. A.
Taylor, Ralph E.
Wall, Earle R.
White, Richard D.
Williamson, Harry

PLAQUEMINE
Barry, John O'Keefe
Wilbert, Louis J., Jr.

RUSTON—Laskey, G. E.

SHREVEPORT—Aimer, James D.
Alexander, Clyde W.
Anderson, Tom A.
Barret, William M.
Bartell, Laurence D.
Barton, Louis A.
Becker, Raymond C.
Benke, Roy
Blanpied, B. W.
Borden, S. P.
Braunstein, Jules
Buchner, Harry M.
Cartwright, Weldon E.
Caster, E. L.
Chapman, R. T.
Clark, Chester C.
Cochran, Phil K.
Corbin, Milton W.
Cox, H. Mack
Cram, Edward C.
Crider, Albert F.
Crow, L. M.
Day, Clarence O.
Eaves, Everett
Fischer, Victor N.
Flesh, David J.
Frazell, W. D.
Freed, Richard
Gill, J. Willard
Goldstein, August, Jr.

Grage, Victor P.
Green, George Gardiner
Grigsby, Garland O.
Grubbs, David M.
Hardin, V. A.
Harlowe, Leslie S.
Hawley, L. David
Hazzard, Roy T.
Henson, G. R.
Hoffmeister, William S.
Hutson, E. B.
Jackson, Alvin M.
Jones, John Percy
Kamb, Hugo R.
Kerlin, M. L., Jr.
Kreidler, William Lynn
Lillibridge, Harry E.
Lloyd, Abe M.
Lytle, J. Edward
Magale, John F.
Marshall, Lester R.
Marshall, W. H.
McFarland, L. R.
McKnight, C. R.
McLaren, Robert L.
Meltzer, Lee Hillard
Miller, E. Floyd
Mix, Sidney E.
Monsour, Eli T.
Moody, Clarence L.
Moody, John D.
Packard, Sidney A.
Parker, Lloyd S.
Plaster, William M.
Purzer, Joseph
Rand, William W.
Rank, R. A.
Robinson, Van D.
Safanov, Anatole
Schwartz, Channing B.
Shearer, Harold K.
Smith, Lloyd B.
Spears, Walter H.
Spofford, Howard N.
Spooner, W. C.
Stewart, Charles A.
Stiller, Ernest A.
Swain, Fred M.
Thomas, George Dewey
Totten, Robert Briggs
Vernon, Benton R.
Wallace, William Edwin, Jr.
Walton, George G.
Weeks, Warren B.
Weintz, Clement A.
Weltman, Louis H.
Whitwell, E. V.
Williams, John R.
Wilson, Richard M.
Young, Jackson S.

SULPHUR—Dunlap, John C.
Farley, William Richard
Kilian, Harry
May, George N.
Melsheimer, Albert H.
Whatley, James M.

THIBODAUX—Cooke, E. E.

WHITE CASTLE
Aycock, Lester C.

WINFIELD—Wade, R. T.

MAINE

SKOWHEGAN—Smith, George Otis

MARYLAND

BALTIMORE—Dorsey, Geo. E.
Nance, J. B.
Singewald, Joseph T., Jr.

CUMBERLAND
Malamphy, Mark C.

OAKLAND—Reeves, Frank

MASSACHUSETTS

BOSTON—La Croix, Morris F.

CAMBRIDGE—Lane, Alfred C.
Mather, Kirtley F.
Smith, Norman C.
Snow, Robert D.
Whitehead, W. L.

CAPE COD—Haskell, N. A.

LINCOLN—Beers, Roland

NORTHAMPTON
Shaub, Benjamin M.

SHARON—Cushman, Joseph A.

SPRINGFIELD—Robinson, Joseph

MICHIGAN

ALLEGAN—Nicola Oliver P., Jr.

ANN ARBOR
Belknap, Ralph L.
Kellum, Lewis B.
Landes, Kenneth K.
Lovering, T. S.

CASSOPOLIS
Bishop, Margaret Stearns

GRAND RAPIDS
Hunt, Raymond S.
Roberts, Richard L.
Smith, Robert Harlowe
Whitney, Paul B.
Wyckoff, J. W.

GROSSE POINT
Keller, P. Hastings

LANSING—Buttermore, Paul M.
de Cousser, Kurt H.
Grant, Rex P.
Martin, Helen M.
Smith, Richard A.
Wynn, Warren H.

MIDLAND
Alquist, Francis Nelson
James, Jay R.

MT. PLEASANT
Brown, William F.
Clark, William A.
Lamar, Lee C.
Moses, Carl E.
Schulz, William M.
Sleight, Glenn C.
Stewart, Norman R.
Thomas, William A.

ROSCOMMON
Fugate, Ross James

SAGINAW—Addison, Carl C.
Baltrusaitis, Edward Joseph
Beeker, Ralph E.
Kirkham, Virgil R. D.
Maebius, Jed B.
Osgood, Manley, Jr.

SPRING LAKE—Boos, Edward J.

MINNESOTA

MINNEAPOLIS
Donovan, Percy W.
Emmons, William H.
Hill, Robert Grant
Stauffer, Clinton R.

MISSISSIPPI

GRENADA—Nuckolls, W. C.

HATTIESBURG
Houston, Sam H., Jr.
Munroe, Donald J.

JACKSON—Chawner, William D.
Dennis, Lyman Clark
Dockery, W. Lyle
Foran, William T.
Gentry, H. L.
Grubb, Carl F.
Harrell, David C.
Harris, R. Merrill
Holston, A. A.
Hood, Forrest W.
Hughes, Urban B.
Jeffreys, Geoffrey
McCoy, Joseph H.
McGlothlin, Tom
Meagher, D. Pope
Mellen, Frederic F.
Michael, James F.
Morgan, Cecil L.
Murray, Grover, Jr.
Reese, Donald M.
Rouse, John T.
Spooner, K. K.
Storey, Joseph B.
Sullivan, Albert M.
Talley, Gilbert A.
Toler, Henry N.
Womack, Brame

KOSCIUSKO—Loomis, F. B., Jr.

LAUREL—Reed, Paul C.

LEXINGTON—Evans, Vincent

MERIDIAN
Knutson, C. J.

OKOLONA—Everett, Rizer

TUPELO
Jenkins, George Marvin

UNIVERSITY—Morse, W. C.

VICKSBURG
Hendy, William J., Jr.

MISSOURI

COLUMBIA—Blackstone, D. L.
Branson, E. B.
Mehl, M. G.

JOPLIN—Fowler, George M.

KANSAS CITY—Bartle, Glenn G.
Burt, Roy A.
Smith, Rufus M.

LOUISIANA—Rife, Byron

MOUND CITY
Rogers, Andrew J.

MOUNTAIN VIEW
Ferrell, Max E.

ROLLA—Buehler, H. W.
Ellison, Samuel P., Jr.
Greene, Frank C.
McQueen, Henry S.
Muilenburg, Garrett A.
Noble, Gilbert W.

ST. LOUIS—Bakke, W. E.
Briscoe, Glenn O.
Stearn, Noel H.
Wheeler, H. A.

WEBSTER GROVES
Buchner, Carl F.

MONTANA

BAKER—Munro, James H.

BILLINGS—Berg, Karl A. E.
Hageman, Donald E.

BUTTE—Hanes, Vincent Eugene

COLUMBUS—Grant, Paul A.

CUT BANK—Hupp, John Ervin
McCourt, James H.
Postle, Gordon L.

HELENA—Ellis, John Reese

NYE—Broedel, Carl Huntington

WARREN—Enders, Dean W.

NEBRASKA

FALLS CITY—Buck, Charles E.
Cheyney, Alvin E.
Clark, James E.
Earl, Will F.
Huffman, Edward A.
Johnson, Edward W.
Neiler, William Dixon

KEARNEY
Turner, Johnathan Douglas

LEIGH—Hunt, Leo Frank

LINCOLN—Lugn, A. L.
Reed, Eugene C.
Scherer, Oliver J.
Schramm, E. F.
Thomas, Harold S.

MCCOOK—Dunbar, Robert O.

MORRILL—Matheny, H. Claire

OMAHA—Wegemann, Carroll H.

ROGERS—Liming, John A.

NEW JERSEY

ELIZABETH—Jameson, M. H.

GREEN VILLAGE

Conway, W. P., Jr.
METUCHEN—Rhodes, Edward J.
Ryan, Thomas P.
MONTCLAIR
Leibensperger, Raymond
NEW BRUNSWICK
Hayes, Albert O.
PITMAN—Lupton, John H.
PRINCETON—Crowl, G. H.
Fox, Steven K.
Knight, J. Brookes
Maxwell, John Crawford
Sampson, Edward
Thom, W. T., Jr.
TENAFLY—Lilley, Ernest R.
UNION CITY—Nordman, O. E.

NEW MEXICO

ALBUQUERQUE—Reiche, Parry
ARTESIA—Yates, Harvey E.
CARLSBAD
Adams, John Emery
Harley, G. Townsend
Kraus, Edgar
Morgan, Robert Edward
Riggs, George D.
Wills, Neil H.
HOBBS—Davis, Roger H.
Miller, Charles P.
Scott, Wilton E.
Staley, Glenn
Stapp, Wilford Lee
Tanner, Hugh A.
JAL—DAVIS, W. K.
Miller, Powell W.
LAS CRUCES
Dodge, Theodore A.
PORTALES—Robbins, H. Weston
ROSWELL—Barnett, J. A.
Cave, Harold S.
Headley, Joseph B.
Thurman, Franklin A.
SANTA FE—Maxwell, Ross A.
SOCORRO—Bates, Robert L.
Needham, Claude E.
Thompson, M. L.

NEW YORK

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BRONXVILLE—Naramore, Chester
BUFFALO—Reeves, John R.
CANTON—Brown, Robert Wesley
DOUGLASTON, L. I.
Thompson, Lester S.
GLOVERSVILLE—Olsson, Axel A.
ITHACA—Harris, Gilbert D.
Nevin, Charles M.
Palmer, Katherine, V. W.
Ries, Heinrich
JACKSON HEIGHTS, L. I.
Farish, Linn M.
NEW YORK—Adams, Clyde B.
Anisgard, Harry W.
Bain, H. Foster
Baker, Norval E.
Baker, Raymond F.
Bartlett, Fred W.
Behre, Charles H., Jr.
Bleecker, Edward S.
Brodie, Gerson H.
Brokaw, Albert D.
Case, William B.
Clapp, F. G.
Cobb, Margaret C.
Condit, D. Dale
Corbett, Clifton S.
Coryell, Horace N.
Cotner, Victor
Cox, Benjamin Burton
Crum, Harry E.
Davis, Robert J.
Dinsmoor, C. G.
Dixon, A. Faison
Dresser, Myron A.
Eagles, Homer M.
Echols, Dorothy Jung
Ely, Fred B.
Estabrook, Edward L.
Fath, A. E.
Finch, John Wellington
Flagler, C. W.
Fuellhart, Donald E.
Garnjost, Frederick W.
Grove, B. H.
Hamilton, Charles W.
Haynes, Winthrop P.
Herald, Frank A.
Herold, John S.
Hindes, E. P.
Holman, Eugene
Hubbard, Bela
Jablonski, E.
Kalb, J. L.
Kay, Fred H.
Kay, G. Marshall
Kinney, Harry D.
Knebel, G. Moses
Kraft, Philip
Langlois, Alice
Lovejoy, John M.
McCulloch, Joseph P.
McKee, H. Harper
Merritt, Roy W.
Miller, William Dana
Minkofsky, Anna
Moore, Carl Allphin
Munoz, Robert R.
Olson, Walter S.
Paige, Sidney
Pertusio, Serge M.
Pogue, Joseph E.
Pratt, Wallace E.
Sealey, Fred C.
Skeels, Dorr Covell
St. Clair, Stuart
Stebinger, Eugene
Tong, James A.
Townsend, R. M. F.
van der Linden, B. H.
von Estorff, F.
Walters, Ray P.
Washburne, Chester W.
Wasson, Harold J.
Weeks, Lewis G.
Whetsel, R. V.
Whiton, Herman F.
Zavoico, Basil B.
POUGHKEEPSIE
Warthin, Aldred S., Jr.
ROCHESTER
Grossman, William L.
Singewald, Quentin D.
SCHENECTADY
Holland, Aaron E.
SYRACUSE—Apfel, Earl T.
WELLSVILLE
Young, Wilber H., Jr.

NORTH CAROLINA

CHAPEL HILL
Huddle, John Warfield
McCampbell, John C.

NORTH DAKOTA

BISMARCK—Cobban, William A.
Downs, George R.
Fulton, Loris J.
Hennen, Ray V.
Seager, O. A.
GRAND FORKS
Laird, Wilson M.

OHIO

CINCINNATI—Caster, Kenneth E.
Rich, John L.
CLEVELAND
McCloy, Walter L., Jr.
Newell, H. Willard
Robinson, J. French
Smoots, John P.
CLIFTON—McCullough, A. S.
COLUMBUS—Lockett, J. R.
Rehn, E. E.
Ring, Dewitt T.
Spieker, Edmund M.
FINDLAY—Donnell, James C.
Emery, Wilson B.
Funk, Fred J.
Koenig, Ralph A.
Shade, E. Bruce
Thomas, George T.
Walter, H. G.
LIMA—MacDonnell, James A.
TOLEDO—Lindberg, George D.
YOUNGSTOWN—Neely, Joseph

OKLAHOMA

ADA—Jones, Boone
Laves, U. R.
Rixleben, Bruno
Witherspoon, Edgar
ANADARKO—Edstrom, Donald E.
ARDMORE—Bartram, Paul L.
Callahan, Drury V.
Fell, Harold B.
Gill, J. P.
Lees, Laurence F.
Marshall, John
Milner, Charles A., Jr.
Neighbor, Frank
Neustadt, Walter, Jr.
Pickering, Warren
Rose, Stanford L.
Tomlinson, Charles W.
Westheimer, Jerome M.
White, Maynard P.
BARTLESVILLE
Absher, William F.
Allen, Harris Hayes
Ambrose, A. W.
Barclay, Stewart
Beck, A. F.
Charles, Homer H.
Clark, Clare M.
Clark, Robert P.
Courtier, William H.
Crawford, F. W.
Crumley, R. F., Jr.
Dietert, Arthur E.
Doan, R. L.
Elliott, George R.
Graham, B. L.
Hiestand, Thomas C.
Hintze, A. J.
Hoffman, Charles C.
Hoke, T. C.
Johnson, Lester H.
Jones, Daniel J.
Kidd, Robert L.
Lott, Frederick S.
Lounsbery, D. E.
Miller, Vincent
Moss, Rycroft G.
Murphy, P. C.
Myers, LeMoyne W.
Nisbet, John M.
O'Keeffe, H. W.
Olson, Walter Sigfried
Potter, Nelson B.
Quesenbery, Alice M.
Reid, Robert P.
Riise, J. A., Jr.
Ruwwe, John W.
Sands, J. M.
Shirk, Wilmer R.
Stirtz, W. Melvin
Thams, William H.
Thompson, Edwin I.
Tribble, Margaret A.
Tucker, R. H.
Weirich, T. E.
Wells, Murray J.
Wilhelm, Arthur K.

BRISTOW—Bisbee, Wallace A.
CHANDLER—Wagner, J. Basil
CHICKASHA—Allon, Michael
CLEO SPRINGS—Herald, J. M.
COWETA—Vernon, I. J.
CUSHING—Ellison, Charles W.
DUNCAN—Gouin, Frank
Parsons, Claude P.
Smalley, Claire F.
DURANT—Montgomery, Phil C.
EDMOND—Relf, George O., Jr.
ENID—Clifton, R. L.
Ford, Carl S.
Reeves, J. R.
Van Zant, James H.
EUFAULA—Mowrer, Loren E.
FORT SILL—Bush, Robert Ewell
Suffield, Harry F.
HENRYETTA—Davis, Leon V.
Morris, Walter W.
HOBART—Russom, Vaughn W.
HOLDENVILLE—Feather, Virgil G.
HUGO—Tyler, H. Johnson
JAY—Valerius, M. M.
KONAWA—Jordan, J. B.
MADILL—Brillhart, Norman W.
Northrip, Gerald Albert
MCALESTER—Jones, Charles T.
NASH—Wethington, W. O.
NELSON—Bryan, Frank
NORMAN
Arper, William B., Jr.
Bednar, William Carr
Cloud, Wilbur F.
Decker, Charles E.
Dott, Robert H.
Frederickson, Edward A.
Gibson, George Drew
Gould, Charles N.
Hamner, Francis M.
Howard, George C.
Lalicker, Cecil Gordon
Melton, Frank A.
Monnett, V. E.
Oakes, Malcolm C.
Smith, Ralph E.
Stratton, J. L.
Wilson, Ivan F.
OILTON
Anderson, Oscar S., Jr.
OKLAHOMA CITY
Akers, Wilburn H.
Bale, Hubert E.
Ballard, William Norval
Barton, Jack M.
Brauchli, R. W.
Brown, H. Travis
Brown, Vergil N.
Burress, George Howard
Buttram, Frank
Camp, Richard W.
Carpenter, M. E.
Claiborne, Ray E.
Clinkscales, Albert S.
Coleman, Tom L.
Conkling, R. A.
Dahlgren, E. G.
Danielson, G. Otis
Davis, Clyde E.
Earle, Francis, Jr.
Ellison, Kenneth A.
Faust, Josef
Frizzell, Mildred Armor
Gile, Richard E.
Hamilton, C. E.
Hancock, Bob
Hicks, I. Curtis
Hoover, F. Mabry
Howard, Dan O.
Hurry, Phil
Jones, Roy D.
Keeler, Clifton M.
Kite, William C.
Laughbaum, Graydon H.
Laughlin, R. W.
Lewis, William Dabney
Lynn, Robert H.
Marvin, Gaurd S.
McFarland, Earl R.
McGee, D. A.
McIntyre, George T.
Miller, Willard L.
Montgomery, A. J.
Moreman, Walter L.
Newby, Jerry B.
Nichols, P. B.
Norville, Glen S.
Ohern, D. W.
Pasquella, George G.
Patterson, Luther Edwin, Jr.
Perrine, Irving
Pollard, Robert T.
Ramsey, Charles E.
Richards, A. H.
Richards, J. T.
Schaeffer, Hugh C.
Schweer, Henry F.
Sears, Joseph M.
Shields, Fred C.
Sisney, E. W.
Smith, Gerald N.
Taylor, Charles H.
Turner, Joseph H.
Van Dall, John E.
Whiting, Lester L.
Woodward, George E., Jr.
Yoakam, Coler A.
PONCA CITY—Athy, Lawrence F.
Boyd, W. Baxter
Clark, Glenn C.
Clark, Stuart K.
Ewing, Rudolph V.
Hornung, A. C.
Hunter, R. Lee
Mills, R. van A.
Morgan, D. M.
Parker, Everett C.
Prokesh, Hugh E.
Royds, James S.
Spain, David S.
PRAGUE—Klabzuba, Robert E.
PURCELL—Perkinson, Floyd
SAPULPA—MacKay, Hugh
SEMINOLE—Barrett, Henry H.
Couser, C. W.
Engleman, Rolf
Hyatt, Don L.
Kline, Robert W.
SHAWNEE—Brown, Robert
Campo, Henry Andrew
Carpenter, Everett
Cassingham, Robert L.
Dawson, Edwin A.
DeLong, James A.
Gahring, William R.
Goodman, P. W.
Goudy, Louis W.
Hestbeck, Marion E.
Hoyle, Charles R.
Jenkins, Harold D.
Johnston, John C.
Kittredge, M. B.
Lee, John E., Jr.
Lehman, Roy P.
Meyer, Arthur M.
Muir, J. Lawrence
Quiett, Roy C.
Rau, Harold L.
Roberts, M. C.
Spangler, Grant W.
Veeder, John A.
Wallace, P. A.
SULPHUR—Wynne, H. C.
TULSA—Ackers, A. L.
Adams, Kilburn E.
Allen, William Odis, Jr.
Arnold, Henry C.
Arnold, H. H.
Arnold, Lincoln M.
Bace, A. C.
Bartram, John G.
Bass, N. W.
Bates, R. P.
Beck, Elfred
Becker, Dwight L.
Becker, Herman Carroll
Beekly, Albert L.
Bennett, Frank O.
Bernard, W. E.
Berwald, W. B.
Bishop, F. L.
Bleakley, Alfred B.
Bloesch, Edward
Bohart, Philip H.
Borden, Joseph L.
Born, W. T.
Bradish, Beverly B.
Brant, Ralph A.
Brown, Harry J.
Brown, Merritt H.
Bryant, Howard S.
Buckstaff, Sherwood
Bullard, Edgar F.
Bush, Frederic A.
Butt, William H.
Carlson, Charles G.
Case, Leslie C.
Chapman, M. E.
Clark, Frank Rinker
Clark, Howard
Clark, Joseph Marsh
Clark, L. W.
Clarke, Ralph L.
Clote, Thomas A.
Coffin, R. Clare
Conhaim, Howard J.
Cornelius, Lee H.
Coryn, F. R.
Cronin, K. Stewart
Cullen, Ronald J.
Cumming, Alfred
Dannenberg, R. M.
Davis, Sidney H.
Denison, A. R.
Desjardins, Louis H.
Dillard, W. Reese
Dille, Glenn Scott
Eckenwiler, Cleo W.
Egan, J. A.
Eirich, Constance G.
Elson, William H.
Emrick, D. G.
Feagin, Barney, Jr.
Ferguson, John L.
Finley, J. C.
Fitts, L. E., Jr.
Fitzgerald, Paul E.
Foley, Lyndon L.
Forney, Maurice E.
Fosshage, E. W.
Gardner, James H.
Garrett, Robert E.
Gartner, James L.
Gawthrop, R. M.
Gilmour, Andrew
Giltinan, George M.
Ginter, Roy L.
Goodrich, Harold B.
Graeber, Clyde P.
Green, Thomas Henning
Green, William G.
Griffith, Glenn R. V.
Grigsby, R. B.
Hall, Dollie Radler
Hamilton, Robert G.
Hardison, George P.
Harlton, Bruce H.
Harris, S. F.
Hatcher, Oscar
Hawkes, Wendall H.
Hawkins, Glenn D.
Heeren, Julius A.

Henry, W. W.
Hewett, Charles F.
Hill, Orval H.
Hill, V. G.
Hollingsworth, R. V.
Hoover, James B.
Hopper, Walter E.
Horkey, William E.
Hosterman, John F.
Howard, W. V.
Howell, J. V.
Hudgens, Clyde O.
Hudson, Oscar M.
Hughes, Richard
Hull, J. P. D.
Hunt, Lenora May
Innes, Arland I.
Johns, Wendell S.
Jones, Leland W.
Kauffman, James S.
Kennedy, Luther E.
Kiess, Myron C.
Kimball, Kent K.
King, Charles C.
Kirk, Charles T.
Kister, Herbert H.
Kleen, Harold J.
Knappen, Russell S.
Kravis, Raymond F.
Kridler, George M.
Kyle, Jerry R.
Lambert, Gerald S.
Lancaster, D. Kenneth
Lane, C. W.
Lang, William J.
Larkin, Pierce
Leach, Thomas W.
Leatherock, Constance
Leiser, J. B.
Lester, O. C., Jr.
Levorsen, A. I.
Lindner, Joseph Leicht
Littlefield, Max S.
Lukert, Louis H.
Lund, Wesley R.
Lyons, Paul L.
Maples, Steve C.
Markham, Edmond O.
Markley, Elmer A.
Marshall, J. W.
Mauck, Melvin Dwight
McCollum, Leonard F.
McCoy, Alex W.
McCrary, E. W.
McGirl, J. N.
McIntyre, Paul J.
McMillen, Raymond F.
McMorris, William Albert, Jr.
Merritt, John W.
Milek, Andrew
Miller, B. Maxwell
Miller, Wendell Z.
Millikan, C. V.
Millison, Clark
Monahan, Foster M.
Moore, Kenneth B.
Morero, Joseph E.
Morley, Harold T.
Mosburg, Lewis G.
Moses, Harold F.
Mossman, R. W.
Murphy, James K.
Murray, A. N.
Musselman, George A.
Neal, E. Preston
Nelimark, John H.
Neumann, L. Murray
Newman, Thomas F.
Norling, Donald L.
Nufer, D. C.
Oliphant, A. G.
Oliphant, Charles W.
Paterson, Robert
Patton, Roger R.
Peabody, Harlan W.
Peaker, Don H.
Perry, Waynard Burton
Phillips, Ross M.
Pishel, Max A.
Price, James A.
Price, Sylvan S.
Probst, Karl Max
Rae, Colin C.
Randall, Duane C.
Redfield, John S.
Reisher, Paul H.
Reynolds, Karl W.
Richards, Raymond
Riggs, Robert J.
Roark, E. L.
Roark, Louis
Roark, R. B.
Ross, Charles M.
Russell, William L.
Rutledge, R. B.
Ryniker, Charles
Scott, H. M.
Scudder, E. W.
Seaman, L. O.
Shamblin, W. Earle
Sharpe, Joseph A.
Shea, E. F.
Sherry, William J.
Shutt, Roscoe E.
Silverman, Daniel
Simpson, Richard W., Jr.
Sinclair, W. B.
Siverson, G. C.
Sloan, Raymond D.
Snow, Dale R.
Solliday, A. L.
Spahr, Marshall Richard
St. Clair, Donald W.
Stoker, Carl E.
Stoner, O. E.
Stotler, Raymond T.
Strachan, Clyde G.
Stump, Mark E.
Taber, Edward Carroll, Jr.
Tandy, J. Hiram
Tarr, Russell S.
Teis, Maurice R.
Templeton, James B.
Tillotson, Allen W.
Travis, Abe
Truex, Arthur F.
Tuttle, R. C.
Upp, Jerry E.
Vernon, Jess
Wagner, Carl D.
Wagner, Clyde L.
Wagoner, George E.
Wails, Elmer D.
Walker, Lucian H.
Watson, Joseph D.
Weatherby, B. B.
Weimer, Frank G.
Welch, Virgil H.
Wellman, Dean C.
Wenberg, Edwin Hugo
Westby, Gerald H.
White, Kirk S.
White, Luther H.
Wilcox, Stanley W.
Willis, S. Morse
Wilshire, L. M.
Wilson, Walter B.
Wood, Robert H.
Wood, Virgil O.
Woods, Sam H.
Wright, Harry F.
Wyman, Everett A.
Zoller, Lawrence J.
WATONGA—Kolm, Paul H.

OREGON

PORTLAND—Williston, Samuel H.

PENNSYLVANIA

BRADFORD—Eckert, Frank E.
Fralich, Charles E.
Simmons, Arthur C.
Stephens, Maynard W.
COOPERSTOWN—Small, Walt M.
COUDERSPORT
Cole, Adna Malone
Whorton, Chester D.
DELMONT
Zimmerman, James Z.
EASTON—Ward, Freeman
GERMANTOWN—Giles, John M.
OIL CITY
Montgomery, James G.
Secor, Donald T.
Seifert, Wilbur H.
PHILADELPHIA—Ellis, George L.
Griley, Horace L.
Harris, Richard C.
Mason, John F.
Pike, Sumner T.
Weeks, Herbert J.
White, Tell T.
PITTSBURGH—Allen, Frank T.
Backman, John E.
Boots, Paul H.
Brankstone, Hugh R.
Bristley, L. P.
Bryan, Carl L.
Davis, Ralph E.
Durham, James H.
Eckhardt, E. A.
Fettke, Charles R.
Finn, Fenton H.
Foster, Alden W.
Galey, John Taylor
Gealy, Wendell B.
Gemmell, Howard F.
Gibbs, Harley S.
Goodman, John V.
Gulley, M. Gordon
Hastings, Wynne K.
Heald, K. C.
Hopkins, Richard H.
Kerbow, Russell B.
Lang, Ralph H.
Melchior, Louis F.
Nettleton, L. L.
Newlon, J. H.
Patnode, H. Whitman
Rand, Wendell P.
Rhoades, Ralph O.
Ross, Ralph B.
Rumsey, Nelson J., Jr.
Schillhahn, E. O.
Sherrill, Richard E.
Somers, Ransom E.
Tolmachoff, I. P.
Vance, W. R.
Watson, George R.
Wylie, James R., Jr.
PLEASANTVILLE
Dickey, Parke A.
PORT ALLEGANY—Gaddess, Jack
Walters, Mason G.
PROSPECT—Shaffer, John M.
STATE COLLEGE
Pelto, Chester R.
Pirson, Sylvain J.
UPPER DARBY
Dickerson, Roy E.
WELLSBORO—Van Gilder, H. R.

SOUTH DAKOTA

RAPID CITY—Tullis, Edward L.
VERMILION—Rothrock, E. P.

TENNESSEE

COLUMBIA—Butters, Roy M.
GUILD—Frink, John W.
KNOXVILLE—Parhiala, Leimo I.
NASHVILLE—Born, Kendall E.
Ferguson, Herman W.

Glenn, L. C.
Wilson, Charles W., Jr.

TEXAS

ABILENE—Byram, John P.
Deuth, Martin J.
Haase, Fred M.
Hall, Ellis A.
Maxwell, Riley G.
Merry, Edward T.
Nowels, Kenneth B.
Perini, Vincent C., Jr.
Stall, Trovall Lafayette
Taylor, Cyril B.
Wright Ray H.
ACKERLY—Hakes, Willard R.
ALBANY—Madden, Lloyd W.
Robie, Robert Hodges
Stasney, H. R.
ALICE—Blanchard, J. B.
Blanchard, Stanley W.
Blouin, Cecil F.
Cannan, Morris
Davidson, J. P.
Franks, Robert M.
Short, Richard T.
Uri, Joseph John
AMARILLO—Anderson, Carl C.
Armstrong, Earle N.
Britt, Harry M., Jr.
Clark, G. C.
Craig, T. C.
Devin, Fred A.
Dougherty, Jack Francis
Gude, Leo J.
Hagy, Lawrence R.
Hemsell, Clenon C.
Henderson, W. D.
Hoover, William B.
Hughes, C. Don
Kautz, Archie R.
Mohler, Donald P.
Oles, L. M.
Paschal, Elisha A.
Peterson, Clarence J.
Powers, Elliot H.
Punches, Richard Knapp
Rogatz, Henry
Rumsey, Edward W.
Rusk, Willard W.
Thompson, James D., Jr.
Tichy, James R.
Van Tine, Arthur B.
Wagner, C. Richard, Jr.
ARLINGTON—Lynch, S. A.
ATHENS—Morgan, Aubrey A.
AUSTIN—Bramlette, William A.
Bullard, Fred M.
Bybee, Hal P.
Byram, R. W.
Cook, Carroll E.
Cuyler, Robert H.
Damon, H. Gordon
DeLancey, Charles J.
Eifler, Gus Kearney
Gardner, Frank J.
George, W. O.
Hendricks, Leo
McCammon, John H.
McNutt, G. R.
Parker, Travis J.
Plummer, F. B.
Power, Harry H.
Redfield, Robert C.
Sellards, E. H.
Snider, L. C.
Stenzel, Henryk B.
Teagle, John
Weeks, Albert W.
Whitney, F. L.
Winkler, Hans
BAY CITY—Fryou, Joe A.
BEAUMONT—Bartlett, C. Lothrop
Braugh, Donald D.
Claypool, C. B.
Denton, Harold
Durgan, Herbert L.
Justice, Philip S.
La Touche, John D.
Pack, R. W.
Rose, Harrison W.
Schroeder, Kingsley V.
Todd, Oliver J., Jr.
BEEVILLE—Barnett, D. G.
Gully, Philip D.
Miller, David M.
Senseman, R. B.
Shayes, Fred P.
BIG SPRING—Barnes, Chester F.
BORGER—Van Sant, John S.
BRADY—Olson, O. C.
BRECKENRIDGE—English, Leon E.
BRENHAM—Ferguson, W. B.
BROWNFIELD—Dana, R. H.
Ferguson, Carlos M.
BRYAN—Vance, Harold
CAMERON—Kittredge, Frank R.
Robinson, B. F.
CAMP BOWIE—Bates, Charles C.
COLEMAN—Anderson, Robert G.
Cheney, M. G.
COLLEGE STATION
Bacon, Charles S., Jr.
Hartley, Burton
Smith, J. Fred, Jr.
Toulmin, Lyman, Jr.
Turner, Francis Earl
CORPUS CHRISTI
Alagood, Robert H.
Ballard, James L.
Benson, Dale L.
Bivens, W. E., Jr.
Bong, Carl P.
Buck, Cleo Eugene
Burke, James D.
Cardwell, William Henry
Clark, J. Tate
Cunningham, Carleton J.
Day, Willard L.
Ferguson, M. L.
Fisher, Dunbar A.
Fletcher, Claude Osborne
Gaenslen, George
Gierhart, Guy B.
Hagan, Arthur M.
Hancock, J. M.
Hansell, James M.
Heaton, A. H.
Herring, L. B.
Isenberger, N. P.
Jolley, Durward N.
Leonard, Clarence Z.
Maley, W. A.
McCallum, Henry D.
Miller, Carroll C.
Nelson, Raymond T.
Orman, Freeman
Orr, Mark L.
Owens, Frith C.
Parrish, Gaston H.
Poole, John C.
Pressler, Edward D.
Price, W. Armstrong
Reid, William McC.
Ross, Donald A.
Scrafford, John Brice
Seevers, Harris N.
Stein, Ira H.
Storm, Lynn W.
Swiger, Rual B.
Taegel, Edwin A.
Travis, J. J.
Tucker, Reagan
Voigt, Harold E.
West, Lloyd G.
CORSICANA—Bescher, Earl, Jr.
Fish, Leroy
McGlothlin, William C.
CUERO—Dexter, Laurence N.
DALLAS—Agnich, Fred J.
Albritton, Claude C., Jr.
Alcorn, James M.
Allen, E. G.
Anderson, Carl T.
Anderson, George H.
Aronson, Sam M.
Bostick, J. Wallace
Bright, Richard T.
Brooks, Olin D.
Brown, Augustus Bart
Burchard, Frederic L.
Burgess, V. N.
Burress, Walter M.
Byrd, David Harold
Carpenter, Charles B.
Carter, Devere V.
Cesinger, E. F.
Clark, John W.
Clawson, Willard W.
Collingwood, D. M.
Collins, C. Philip
Cortes, Henry C.
Cox, W. Philip
Crawford, David J.
Dana, E. B.
DeGolyer, E.
Deputy, P. R.
Doering, John
Dunlap, George E.
Ekholm, Victor E.
Fisher, Barney
Fosdick, Arthur R.
Frost, Jack
Gaby, Edwin D.
Garner, Aubrey H.
Garrett, Melvin M.
Germany, E. B.
Gilmore, Kathleen K.
Graham, Gordon L.
Gray, Alfred
Green, Cecil H.
Guthrie, Robert K.
Hager, Dilworth S.
Headington, Clare W.
Heath, Francis E.
Hill, Harry B.
Joekel, Fred E.
Jordan, Louise
Karcher, John C.
Kelsey, Lewis O.
Kelsey, Martin
Kendrick, Frank E.
Knox, T. K.
Lahee, Frederic H.
Lewis, James A.
Love, Perry R.
Luman, Edmonson D.
MacNaughton, Lewis W.
Mayfield, Gid C.
McCoy, George Y.
McDermott, Eugene
McFarland, Paul W.
McFarland, R. S.
McLeod, Angus
Menefee, James C.
Meredith, Carlton
Meyer, Willis G.
Miller, Lloyd E.
Morgan, Henry J., Jr.
Nash, Paul E.
Newton, William W.
Norton, George H.
Oden, Arthur J.
Oldham, Albert E.
Pernell, James Herbert
Pittman, C. V. A.
Pollard, Jack C.
Porter, Phil
Ralston, Wallace
Ransone, William Robert
Reagor, Edward C.
Rettger, Robert E.

Rider, Charles R.
Robinson, Heath M.
Russ, Leon F.
Russell, P. G.
Sale, Clarence M.
Schultz, Frank August
Schwarz, Melbert E.
Sclater, Kenneth
Seale, Robert I.
Shearer, Louis H.
Sheldon, Wichita F.
Sherwin, M. W.
Shuler, Ellis W.
Simkins, J. J.
Smith, Eugene W.
Somers, George B.
Sprengling, Kurt
Stehr, Raymond A.
Stephenson, C. D.
Stevens, Nelson P.
Tapper, Wilfred B.
Teichman, Joseph B.
Thompson, Sheridan A.
Toomey, Eugene James
Valerius, Claude N.
Vanderpool, Harold C.
Walton, O. E.
Waters, James A.
White, Rex H.
Willimas, Charles C.
Wilson, E. E.
Wilson, Joseph M.
Wilson, Malcolm E.
Wrather, W. E.

DENTON—Edson, Fanny C.

DONNA—Huntley, Louis G.

EAGLE—Moir, John

EASTLAND—Perkins, Joseph M.
Steel, Robert J.

EDINBURG—North, Lloyd

EL PASO—Helmig, Phil D.
Millard, William J.
Nelson, Lloyd A.

FORT BLISS—Newell, Donald F.

FORT STOCKTON
Samuell, John Howard

FORT WORTH—Abbott, John L
Adkisson, Albert
Allen, Alton C.
Applin, Paul L.
Aurin, Fritz L.
Bass, Perry R.
Bennett, Ethel Evans
Benton, L. B.
Berger, Walter R.
Bradfield, Herbert H.
Bradish, Ford
Brown, J. Earle
Canon, Joe
Casteel, S. H.
Christie, Robert S.
Christner, D. D.
Clark, H. Smith
Cordry, C. D.
Cummins, R. H.
Dean, D. P.
Dean, P. C.
Donoghue, David
Fash, Ralph H.
Fisher, Gordon H.
Freedman, L. H.
Fuqua, H. B.
Giddings, H.
Goodrich, Robert D.
Gray, Donald A.
Harbison, Robert R.
Harris, Sidon
Heroy, William B., Jr.
Hilseweck, William J.
Hudson, William A.
Hyde, Clarence E.
Imbt, Robert F.
Johnston, Lois L.
Jones, Park J.
Kennedy, J. B.
Lee, Lynn K.
Lovejoy, J. B.
Lozo, Frank E., Jr.
Markley, Joseph H.
Marshall, F. E.
Maverick, Phillip
McClure, Harold Y.
McCune, Paul
Mohr, C. L.
Morris, James L.
Mygdal, Karl A.
Nicol, David
Nolte, William J.
Pilcher, Ben L.
Poulsen, Frank E.
Powell, Ralph S.
Reeves, Frank W.
Renaud, Charles L.
Reynolds, Roy A.
Romine, Thomas B.
Schouten, Franklin H.
Schweers, Richard Henry
Scott, Gayle
Snebold, William F.
Stookey, D. G.
Taylor, Garvin L.
Thomas, J. Elmer
Thompson, B. E.
Thompson, R. R.
Upson, M. E.
Weaver, George A.
Wilson, John H.
Winton, Will M.
Yager, Charles E.

GAINESVILLE—Wynn, Albert

GALVESTON—Zinke, Ernest C.

GRAHAM—Mort, Frank P.

GROESBECK—Whitcomb, Bruce

HAMILTON—Stiles, Elisabeth

HENRIETTA
Harder, Banhart Pete

HOUSTON—Adams, Frank C.
Adams, W. C.
Adkins, W. S.
Adler, Joseph L.
Akkerman, Richard Pete
Albertson, Maurice M.
Allison, A. P.
Anderson, John G.
Andrau, E. W. K.
Andrews, W. W.
Archie, Gustave E.
Artusy, Ray
Back, Denys H.
Bader, G. E.
Bailey, Thomas L.
Baker, William A., Jr.
Baldwin, E. B.
Banta, H. E.
Barber, Clifford F.
Barragy, Edward J.
Barrow, Leonidas T.
Batla, Thomas Woodrow
Bay, Harry X.
Beatty, Robert M.
Beckelhymer, Roy L.
Beilharz, Carl F.
Bell, Douglas E.
Bell, Olin G.
Belt, Ben C.
Benish, Robert L.
Bennett, Malcolm D., Jr.
Benson, Don G.
Berg, Gilman A.
Best, J. Boyd
Black, Jo Pat
Blau, Ludwig W.
Bleyberg, Arnold
Bocock, Oscar L.
Bolinger, John W.
Boone, Dan E.
Booth, Robert T.
Born, Howard R.
Bostick, Francis X.
Bowles, R. C.
Bowling, Leslie
Bowman, Wayne F.
Boyles, James M.
Brace, Orval L.
Briard, Vernon E.
Bricker, John F.
Brokaw, John M., Jr.
Broussard, David F.
Broussard, Lloyd J.
Brown, Samuel B.
Bruyere, Alan
Buchanan, George S.
Buck, E. O.
Buck, Nina M.
Bugbee, J. M.
Bunsen, A. W.
Burchfiel, Hugh L.
Burkhead, W. Z.
Byers, J. W.
Calohan, William F.
Campbell, F. F.
Campbell, William R.
Cantrell, Ralph B.
Carey, Hillard W.
Carlton, Dave P.
Carr, George W.
Cartwright, Lon D., Jr.
Casey, S. Russel, Jr.
Cashin, D'Arcy M.
Chambers, Jack
Charrin, P.
Childerhose, Allen J.
Christie, Laurence G.
Church, Charles R.
Clark, William A., Jr.
Clark, W. Kenley
Clifford, O. C., Jr.
Cogen, William M.
Colle, Jack Overton
Collett, J. Daviss, Jr.
Collier, John J.
Conrad, Charles S.
Cox, Harris
Crawford, Gayle P.
Crowell, John H.
Cruse, John S., Jr.
Culbertson, J. Archer
Dake, Laurence F.
Davis, Donald M.
Davis, Flavy Eugene
Davis, Morgan J.
Dawson, R. J.
DeBlieux, Charles
Decker, LaVerne
Deming, J. H.
Deussen, Alexander
Dissinger, Earl
Doherty, W. T.
Dorr, James B.
Durkee, Robert R.
Earl, Eugene L.
Eby, J. Brian
Edson, Dwight J.
Elliott, J. E.
Ellis, Albert D., Jr.
Ellisor, Alva C.
Esgen, W. K.
Evans, Frank G.
Evans, Noel
Fahle, Paul B.
Fenn, Ivan J.
Ferguson, Hershal C.
Ferrando, A.
Flowers, Jack
Flude, John W.
Fly, Paul J.
Fohs, F. Julius
Franklin, Louis
Fritts, Harold M.
Frost, Jay Miles, III
Funkhouser, E. M.
Fuqua, Marjorie

Gahagan, Donald I.
Galbraith, T. J.
Gale, Arthur S., Jr.
Gallie, John F.
Galloway, Alan J.
Gardner, Edgar J.
Garrett, J. B.
Garrett, Lovic P.
Getzendaner, A. E.
Gimbrede, Louis DeA.
Golden, John M.
Goldston, Walter L., Jr.
Goldstone, Frank
Goodrich, Raymond H.
Gordon, Dugald
Gorman, William A.
Gray, Shapleigh G.
Gray, William D.
Griffin, Irving M., Jr.
Grinsfelder, Sam
Grogan, Samuel A.
Grosjean, Robert
Guseman, L. F.
Guyod, Hubert
Hafner, W.
Hagen, Cecil Vernon
Hager, Lee
Halbouty, M. T.
Hall, Thomas O.
Halsted, Morris E.
Hamilton, Edward A.
Hamm, W. Dow
Hamman, John, Jr.
Hamner, Edward John
Hancock, William T., Jr.
Hanna, Marcus A.
Hansard, Charles O., Jr.
Hanson, Malcolm B.
Hardison, Harvey
Harkins, T. I.
Harrington, George H.
Harvey, Castle J. C.
Hasselmann, Karl F.
Hedley, J. David
Heid, Gordon W.
Henderson, Marion Reece
Hendrickson, Robert D.
Hensch, C. R.
Herold, C. Lathrop
Heroy, William B.
Hier, Charles Douglas
Higgs, Morton T.
Hinson, Hillord
Hoard, J. O.
Hodder, Roland F.
Holland, Richard M., Jr.
Holmer, Ralph C.
Hornberger, Joseph, Jr.
Horner, William L.
Horvitz, Leo
Housh, C. N.
Hoyt, William V.
Huffmyer, Jack Roach
Hughes, Darrell S.
Hunter, Paul B.
Hussey, Keith M.
Hutchinson, Frederick M.
Igau, Hubert C.
Ikins, William Clyde
Irwin, Carl B.
Israelsky, Merle C.
Ivy, John Smith
Jay, Stanley E.
Jennings, Philip H.
Jenny, W. P.
Jones, Robert L.
Jones, Wayne V.
Judson, Sidney A.
Kelly, John S.
Kemp, H. S.
Kennedy, Gilbert R.
Kerr, James Lee
Kisling, James W., Jr.
Kornfeld, M. M.
Kovac, M. Stephen
Ladner, A. L.
Lake, Charles L.
Lake, James L.
Langton, Claude M.
LaRue, James E.
LaRue, Wilton W.
Lasky, Bernard H.
Lay, Roy L.
Leavenworth, Paul B.
Leonardon, E. G.
Levy, David Jacob
Lewis, James O.
Lewis, Ray C.
Lieb, Victor E.
Loetterle, Gerald John
Lott, Alfred Walker
Lowman, Shepard W.
Lucky, M. C.
Lyons, Richard T.
Mackay, Donald K.
Madera, R. F.
Malkin, Doris S.
Marr, John D.
Martin, B. G.
Martin, Benjamin H.
Martin, Phil F.
Mason, Shirley L.
Mathieu, J. L.
McCarter, W. Blair
McCarver, A. G.
McDonnold, H. W.
McFadden, William A., Jr.
McFerron, George I.
McGowan, F. H.
McLellan, Hiram J.
McMillan, Joseph M.
Meyers, P. A.
Michaux, Frank W.
Miller, Forrest J.
Miller, John C.
Milton, W. B., Jr.
Minor, H. E.
Mitchell, George D., Jr.
Mitchell, Harold D.
Mitchell, Robert B.
Montgomery, James C.
Moore, Homer C.
Moore, William B.
Mornbinveg, A. R.
Morris, A. Ferd
Morris, Louis H.
Morrison, T. E.
Morse, Roy R.
Mower, Lowell K.
Mueller, Frederick W.
Murdoch, Ernest J.
Myers, John C.
Myers, Julian Q.
Nance, A. G.
Neill, Wenzel B.
Nelson, Floyd A.
Neuman, Leonard J.
Niven, Robert N.
Noble, Homer A.
O'Bannon, P. H.
O'Donnell, Lawrence
Olcott, David Perry
Orynski, Leonard W.
Osterhoudt, Walter J.
Owen, Kenneth Dale
Parker, W. G.
Patrick, Walden W.
Pawley, Julian K.
Paxson, Roland B.
Peacock, Henry Bates
Piggott, Guido M., Jr.
Pike, William S.
Powless, R. C.
Pyeatt, Lloyd M.
Rainwater, Edward H.
Ray, Robert H.
Rea, Henry Carter
Reasoner, M. A.
Reed, Edwin M.
Reedy, M. Frank, Jr.
Reiss, John W.
Reiter, Wilhelm A.
Reynolds, F. F.
Richardson, Carl B.
Riddle, James I., Jr.
Ries, Minette
Roberts, Dwight C.
Roberts, Louis C., Jr.
Rolshausen, F. W.
Roper, Frank C.
Rosaire, E. E.
Rose, Nicholas
Ross, E. McIver, Jr.
Runion, Felix A.
Russell, C. A.
Sample, Charles Hurst
Sanders, C. W., Jr.
Sappington, Chester
Sartain, Max R.
Sasse, Jerome B.
Saville, Wilson G.
Sawtelle, George
Say, Stanley R.
Schafer, Sidney
Schilling, Karl H.
Schmidt, Karl A.
Schmotzer, J. W.
Scholl, Louis A., Jr.
Schumacher, J. P.
Schwennesen, Alvin T.
Scruggs, M. Dale
Selig, A. L.
Seren, Gordon W.
Shakely, Ed.
Sheets, Martin M.
Sherar, Edgar Smith
Sherar, Stuart
Simmons, Benjamin Titus
Sisson, Harry Hensel
Smiser, Jerome B.
Smith, A. E.
Smith, Aylwin L.
Smith, Erwin W.
Smith, Fred E.
Smith, Fred Lewis
Smith, Gerald J.
Sorenson, I. L.
Speed, C. D., Jr.
Spoor, Harry C., Jr.
St. Germain, R. J.
Stamey, Roderick A.
Steig, Maynard H.
Stein, F. B.
Steinberger, Clark R.
Stephenson, Elizabeth E.
Stephenson, Morton B.
Stevens, George D.
Stewart, Charles H.
Still, J. T.
Stoddard, Gail H.
Stone, George Bailey
Stuckey, Charles W., Jr.
Suman, John R.
Sundt, O. F.
Sutton, Chase E.
Swigart, T. E.
Tash, George E.
Tatum, Emmett P.
Taylor, Josiah
Taylor, W. Harlan
Teague, J. U.
Teas, L. P.
Teten, R. P.
Thomas, James W.
Thompson, Evan G.
Thompson, John P.
Thompson, Wallace C.
Thomsen, Erik
Todd, John D.
Torrey, Paul D.
Trager, H. Harold
Troxell, John N.

Tyson, Alfred K.
Urbom, Oscar William
Van Burgh, Lisle R.
Van Eaton, Raymond A.
Van Melle, F. A.
Van Steenbergh, S. K.
van Weelden, A.
Vaudoit, Paul L.
Vesely, Leon R.
Vetter, John M.
Vieaux, Don G.
Von Eiff, Herbert C. W.
Wade, Wallace Lee
Walker, Jules Hargis
Wallace, Davis M.
Ward, Roderick C.
Warner, Charles A.
Warren, Howard C.
Waters, Joyce Irene
Weatherston, Douglas
Weaver, Paul
Weingartner, R. A.
Wells, H. P., Jr.
Welsh, Leroy G.
Wender, W. G.
Westmoreland, Frank S.
White, Dan J.
White, Gordon H.
White, James G.
Wilhelm, Oscar G.
Williams, Herbert E.
Wilson, Arthur Noble
Wilson, Ernest B.
Wilson, Forest Wayne
Wolf, Albert G.
Woods, R. D.
Wright, Hugh
Wright, Randall
Young, C. T.
Zaba, Joseph
Zimmerman, C. C.

HUNTSVILLE
Iversen, William G.

IRAAN—Crosby, George E.
Gregory, Peter Paul

KILGORE—Eckart, Robert R.

KINGSVILLE—Allen, Stanley R.
Dismukes, J. S.
Livingston, Noyes B.
Sargent, E. C.
Williams, Carroll L.

LA PORTE—Cooke, H. C.

LAREDO—Buie, Bennett Frank
Campbell, John M.
Drindak, Joseph Thomas
Fountain, H. C.
Orr, Milo M.

LA WARD—Clark, Paul H.
Noland, Orval W.
Pool, Frank Morrow

LOCKHART—Lincoln, W. W.
Wiegand, F. W.

LONGVIEW—Sumner, Walton

LUBBOCK—Crider, Lewis C.
Dunn, David A.
Elkins, Campbell H.
Evans, David Morgan
Gibson, Donald Thomas
Klaus, Hellmut
Lyle, William E., Jr.
Patton, Leroy T.
Robinson, W. I.
Sidwell, Raymond
Stainbrook, Merrill A.
Teas, Paul C.
Von Osinski, William

LULING—Woolsey, E. V.

LYTLE—Mitchell, Mark W.

MADISONVILLE—Hervey, O. S.

MARATHON—Wilson, Homer M.

MARSHALL—Hammonds, G. Scott

MCALLEN—Martin, Edgar E.
Minton, Joseph W.
Monk, John C.
Nichols, C. R.
Parker, Jack A.
Robinson, Cecil D.
Russo, Martin
Smith, Lee C.
Warner, J. Laird

MERCEDES—Coel, E. J.

MEXIA—Liddle, Ralph A.

MIDLAND—Abell, George T.
Allen, William Hammond
Anderson, Frank Marion
Anderson, W. D.
Arick, M. B.
Armstrong, J. M.
Bailey, John J.
Bailey, Willard F.
Barnhart, Carl F.
Bartley, Jerald Howard
Bayer, H. M.
Beckmann, Harry L.
Bingman, Neal J.
Branson, Delmar O.
Brier, Ervin E.
Brock, Stephen W., Jr.
Brown, Prentice F.
Bucher, J. Eric
Butcher, Cary P.
Canfield, Charles R.
Carter, G. R.
Champion, Oscar R.
Chase, C. Louis
Clarke, Robert L.
Clarkson, William George, Jr.
Coil, Fay
Cole, Charles Taylor
Conger, Lauren Tenney
Conkling, Russell C.
Conley, J. N.
Cooley, Ralph S.
Corey, George Simpson
Corman, Hyman
Cox, Robert T.
Crays, Glenn E.
Crump, John R.
David, Max
Day, James R.
DeFord, Ronald K.
Dicken, Russell
Dickey, Robert I.
Donnelly, Alden Stuart
Dougherty, W. E.
Eley, Hugh M.
Ely, George N.
Farmer, Russell
Ferguson, Kenneth S.
Ferrell, Jane
FitzGerald, James, Jr.
Forgeron, Harold S.
Fritz, William Clayton
Funk, Marion H.
Germond, Kenneth W.
Giesey, S. C.
Girdler, Tom M., Jr.
Green, Charles C., Jr.
Haigh, Berte R.
Harper, O. C.
Harrison, John W.
Hartwell, Moreland T.
Hedrick, O. F.
Hemphill, Herbert A.
Herd, John Harvey
Hills, John M.
Hitchcock, Edmund S.
Hord, John Alan
Hyde, Ben Cooper
Irwin, Wallace W.
Kennedy, Joseph B., Jr.
King, Robert E.
Kinkel, W. C.
Kirkendall, James
Koch, Thomas W.
Kotyza, Fred F.
Larsh, N. B.
Leeper, Alan B.
Lewis, Frank E.
Lindeblad, E. E.
Lloyd, E. Russell
Loskamp, Alvin P.
Maley, Vaughn C.
Mann, Robert S.
McGuigan, F. H.
McKay, A. E.
McKinsey, M. H.
Miller, Milward
Mills, Lloyd C.
Mix, C. A.
Moore, John I.
Moore, Lee Wayne
Moore, Prentiss D.
Moxey, Walter G.
Neer, Carl J.
Oles, Paul S.
Osborn, William M.
Parker, T. R.
Penn, William Y.
Pierce, Harold Frederick
Porterfield, R. R.
Quigley, James A.
Rankin, Robert E.
Ray, Bernerd A.
Reed, Edward Looman, Jr.
Reigle, Edward E.
Rogers, Victor W.
Russell, Hewlett A.
Schlosser, Paul A.
Schneider, William T.
Schnurr, Cornelius
Secor, Dana M.
Shaw, Charles A.
Skinner, John Wesley
Spencer, Maria
Taylor, Surce John
Tennis, Langdon C.
Terrill, J. V.
Thomas, Leonard C.
Tompkins, Joseph D.
Umbach, Paul H.
Vanderpool, Eugene W.
Vertrees, Charles D.
Wadsworth, A. H.
Wahlstrom, Edwin A.
Wallace, Louis S.
Ward, C. J.
Warren, John Edwin
West, W. W.
Wilcox, Fred H.
Winter, Niles B.
Woods, E. Hazen
Word, Charles F.
Wright, Fred S.
Young, Addison

MT. PLEASANT—Webb, James A.

MONT BELVIEU—Chun, H. A.

MONTGOMERY—Jackson, J. R., Jr.

NAVASOTA—Agree, Flint H.

NEWGULF—Judson, Wilbur

ODESSA—Boring, M. O., Jr.
Clark, Frank T.
Fisher, Theodore Glen
Griswold, E. H.

OLNEY—Hauptman, Herman R.

OVERTON—Maxwell, Curtis F.
Roberts, Charles V., Jr.

PALACIOS—Barnett, John F.

PALESTINE
McReynolds, Gregg F.
Swesnik, Robert Malcolm

PAMPA—Blanchard, Frank N.
Phipps, J. B., Jr.
Rogers, Jesse A.
Schwartz, H. E.

PEARSALL—Sklar, Maurice

PHILLIPS—Ribble, John M.

PILOT POINT—Elliott, A. C.

PLANO—Chaddick, W. M., Jr.

RIVERSIDE—Weinzierl, John F.

ROSENBERG—Scrogin, John M.
Ustynik, Edwin F.

SAN ANGELO—Cannon, Joe
Cannon, R. L.
Dodson, Floyd C.
Emch, John W.
Gregory, J. N.
Morgan, George D.
Ott, Emil
Ray, W. C.
Simpson, Roscoe M.
SAN ANTONIO
Achning, Walter J.
Alcorn, A. H.
Banks, Thomas R.
Benedum, Darwin
Bevier, George M.
Boehms, Eugene F.
Bonar, R. E.
Boyer, Will W.
Boyle, Walter J.
Brown, Ira Otho
Camp, John F., Jr.
Chapell, D. O.
Closuit, E. M.
Coates, George H.
Coldwell, Charles H.
Colton, Earl G.
Colton, Howard F.
Cooper, Herschel H.
Corning, Leavitt, Jr.
Cottingham, Virgil E.
Cotulla, R. E.
Curry, William H.
Daubert, Charles A.
Daugherty, C. G., Jr.
Davis, Thornton
Dawson, Herbert M.
Dawson, Joseph M.
Derden, J. H.
Douglas, L. A.
Dovre, Adolph
Durward, Robert H.
Elms, Morris A.
Eyssell, Alfred R.
Finch, Elmer H.
Gilbert, A. C.
Gish, Wesley G.
Green, Guy E.
Gross, A. B.
Hammond, Weldon W.
Haring, Louis H., Jr.
Harrell, Marshall A.
Harvey, William W.
Henderson, H. H.
Herndon, Harold D.
Howe, Ralph H.
Howeth, Irving K.
Hunzicker, Vernon J.
Ingham, A. I.
Johnson, E. L.
Kearny, Clinton C.
Kelley, Ward W.
Keppler, Leo G.
Kidd, Gentry
Kirby, Grady
Kniker, Hedwig T.
Kolm, Robert N.
Krum, William M.
Lawton, Joe
Ley, Henry A.
Lueth, Clinton A.
Manthos, Atlee G.
Masterson, Reba B.
Matson, Martin
Mayfield, W. I.
McDonald, Worth W.
McMillan, Robert
Mebane, Robert Duff
Menger, Hubert Emil
Moore, Marion J.
Mossom, Stuart
Nelson, James C.
Nelson, Jean O.
Nessly, Howard E.
Newfarmer, Leo R.
Nicholls, William M.
Osborne, Robert R.
Owen, Edgar W.
Palmer, Leland L.
Parsons, Kenneth R.
Patterson, Joseph M.
Petrick, Glen
Petsch, Arthur H.
Petty, Dabney E.
Petty, O. S.
Petty, Van A., Jr.
Pinkley, George R.
Porch, Edwin L., Jr.
Potter, Grover C.
Powell, Ezra H.
Preece, Rae
Ratliff, Guy Marvin
Renick, B. Coleman
Roberts, Homer E.
Rogers, James K.
Ross, John C.
Row, Charles H.
Rudolph Paul Jackson
Ryan, R. G.
Sandidge, John R.
Sandifer, Donald F.
Schoeneck, Philip S.
Schoolfield, R. F.
Semmes, Douglas R.
Shaw, Silas Frederick
Sheldon, Israel R.
Shelton, George H.
Sloss, James P.
Snider, L. B.
Snow, Arthur Leland
Souther, John B.
Spice, William H., Jr.
Sprague, William B.
Steubing, W. C.
Storm, Willis
Teel, Dick
Tobin, Don Freeman
Traupe, Lloyd D.
Wagener, Charles H.
Ward, Harold E.
Warner, Ralph E.
Whitaker, Harvey
Wilson, James, Jr.
Winfrey, Donald B.
Wiringa, Leon O.
Wofford, H. R., Jr.
SEALY
Hackbarth, Robert Earle
SEMINOLE—Roberts, Gerald C.
SEYMOUR
Kemp, Augusta Hasslock
SINTON—Dake, Helen Elizabeth
Garst, Jarvis
Tatum, James L.
TAYLOR—Grimes, Russell W.
THROCKMORTON
Clowe, Charles E.
TYLER—Alexander, C. I.
Bierman, Alfred C.
Brundall, Laurence
Bunn, John R.
Burford, Selwyn O.
Burnett, T. J.
Burton, George E.
Cardwell, D. Harold
Cash, Thornton C.
Denton, Frank R.
Guinn, Delmar R.
Harden, Lynn L.
Howard, Edward L.
Hudnall, James S.
Moore, Barton W.
Murphy, Boyd F.
Pirtle, George W.
Rice, Elmer M.
Robertson, Parker A.
Self, Selden R.
Shelby, Thomas, Jr.
Thomas, William T.
Trowbridge, Raymond M.
Wendlandt, E. A.
Wilson, Edward B.
Wright, Andrew C.
Youngmeyer, Ray
UVALDE
Getzendaner, Frank M.
VANDERBILT
Bauernschmidt, A. J., Jr.
Patton, J. B.
Timm, Bert Clifford
VERNON—Geyer, Robert L.
VICTORIA—Johnston, Leslie A.
WACO—Blank, Horace R.
Lane, Robert Cecil
WEATHERFORD—Smith, J. P.
WICHITA FALLS
Autry, Vernon E.
Bean, Ward C.
Birk, Ralph A.
Bowen, James P.
Coryell, Lewis S.
Daniel, Orion A.
Davies, Jack W.
Davies, James Dudley
Davis, John R.
Drake, Robert T.
Emmerich, Harry H.
Engstrand, Clinton
Fonville, Herman A.
Gibbs, James F.
Heninger, Dan D.
Hiller, C. F.
Kay, John A.
Kelly, Donald
Kimball, Edgar W.
Langford, David Kemp
Mankin, Warren W.
Martin, P. M.
Maucini, Joseph J.
McGaha, Charles P.
Melzer, Laurence S.
Moore, Fred H.
Moorhead, Johnny
Pettigrew, Virgil
Petty, T. F.
Purcell, Paul E. M.
Rickard, Hilton Lloyd
Roth Robert
Russell, J. J., Jr.
Sanford, Wendell Glenn
School, Guy J.
Seitz, J. R.
Smiley, H. F.
Stilley, Earl M.
Wadsack, George E., Jr.
Waggoner, Stephen Gose
Wanenmacher, Joseph M.
White, Albert William
YORKTOWN—Johnson, Walter

UTAH

LOGAN—Williams, J. Stewart
MOAB, Mayhew, Eldon Jay
SALT LAKE CITY
Bowen, Charles F.
Whittier, William H.

VERMONT

POULTNEY, Larrabee, David M.

VIRGINIA

ALEXANDRIA—Heston, J. Ed
Hoffer, Clarence W.
Joujon-Roche, Jean Edward
Miles, Phil M.
ARLINGTON
Dumbros, Nicholas G.
Morgan, Charles Gill
BLACKSBURG—Holden, Roy J.
CHARLOTTESVILLE
Cederstrom, D. John
McGill, William M.

LANGLEY FIELD
McLendon, Dan Harvey
QUANTICO—Noll, Donald E.

WASHINGTON

FORT LEWIS—Kotick, O. F.
Mathes, Donald E.
OLYMPIA—Glover, Sheldon L.
PULLMAN—Culver, Harold E.
SEATTLE—Knox, John K.
Umpleby, Joseph B.
Weaver, Charles E.

WEST VIRGINIA

CHARLESTON
Anderson, Ray Ball
Barney, A. Y.
Billingsley, J. E.
Brewer, Charles, Jr.
Fischer, O.
Lafferty, Robert C., Jr.
McLain, Alan H.
Simmons, Harvey J., Jr.
Ziebold, William O.

ALBERTA

CALGARY—Bradford, Charles E.
Galloway, John O.
Howells, W. C.
Hunt, Edwin H.
Hunter, Harry M.
Irwin, J. S.
Johnson, Russell V.
Link, Theodore A.
Lockwood, R. P.
MacNeil, Donald J.
Sanderson, J. O. G.
Slipper, S. E.
Spratt, J. G.
Sproule, John Campbell
Thorne, B. L.
Williams, Thomas B.
CLARESHOLM
Chilton, James Ryder
EDMONTON—Allan, John Andrew
Ball, Max W.
Falconer, W. L.
TILLEY STATION
Gleddie, Joseph
TURNER VALLEY
Mackenzie, W. D. C.

ANGOLA

LOANDA—Roschen, Ernest C. H.

ARABIA

JEDDAH—Rigg, Robert M.
KUWAIT—Guntz, Henry A.

ARGENTINA

BUENOS AIRES
Bracaccini, Osvaldo I.
Breitenstein, Robert S.
Dessanti, R. N.
Ducloux, Abel Herrero
Leidhold, Clemens
Martin, Rodolfo
Rozlosnik, Andres
Severson, George A.
Tarragona, Jose
CHUBUT—Catinari, Altavino E.
LA PLATA Fossa-Mancini, Enrico
Suero, Tomas
MENDOZA—Feruglio, Egidio
SALTA—Fields, Harry B.
Harrington, George L.

AUSTRALIA

BRISBANE—Wade, Arthur
Walpole, Leonard W.

CLARKSBURG
Mayfield, William W.
Tollefson, E. H.
LEWISBURG
Argabrite, William Graeme
MORGANTOWN—Folsom, L. W.
Galpin, Sidney L.
Heck, Edward T.
Price, Paul H.
Reger, David B.
Tucker, Rietz C.
PARKERSBURG—Lilligren, J. M.
PRINCETON—Straley, H. W., III
WHEELING—Hubman, Ralph G.

WISCONSIN

MADISON—Feray, Dan Edwards
Hamilton, Irving Boyd
Hardin, George C., Jr.
Newell, Norman D.
Renfro, Harold Bell
Twenhofel, W. H.
PLATTEVILLE—Morgan, Ray E.

WYOMING

BAIROIL—Glass, Theodore G.

OUTSIDE UNITED STATES

CANBERRA—Raggatt, Harold G.
GORDON—Woolnough, W. G.
MELBOURNE
Burnett, Jerome B.
Rudd, Eric A.
SOUTH PERTH—Moss, Frank A.
SYDNEY—Bremner, Carl St. J.
Maddox, Walter H.
Stanley, G. A. V.

AUSTRIA

LEOBEN—Petrascheck, Wilhelm

BARBADOS

BARBADOS—Senn, Alfred

BELGIAN CONGO

BOMA—Hoffmann, Charles R.
COSTERMANSVILLE
Touwaide, Marcel E.

BORNEO

BALIKPAPAN—Schlaich, E. P.

BRAZIL

BAIA—Clayton, Edgar H.
RIO DE JANERIO
Wyszynski, O. W. T.

BRITISH COLUMBIA

VANCOUVER
Gray, John Gardiner

BURMA

KHODAUNG—Lehner, Ernest J.
Hutchison, Arthur G.
RANGOON—Gevaerts, E. A. L.

CANAL ZONE

BALBOA—Arnold, Emmett L.
DIABLO HEIGHTS
Garber, Marshall West
Hilton, Willard O.
FRANCE FIELD
McNab, James

COLOMBIA

BARRANCA-BERMEJA
Mulholland, Malcolm M.
Sheldon, Robert A.
BARRANQUILLA
Chappell, Walter M.
de Escallon, Marion Roberta
McCullough, E. A.
McNaughton, D. A.

CASPER
Crawford, James Gilmore
Barrett, Albert F.
Hares, C. J.
Johnson, Elton D.
Krampert, E. W.
Larsen, Raymond M.
Mallory, R. W.
McCanne, Rolland W.
Nelson, Walter S.
Schoonmaker, George R.
Sielaff, Robert L.
HANNA—Kivi, Wilho J.
LA BARGE—Minton, Robert J.
LARAMIE—Beckwith, R. H.
Espach, Ralph H.
Sansone, John B.
Snively, H. Norman
Thomas, Horace D.
ROCK SPRINGS
Nightingale, W. T.
SHERIDAN—Davis, John Harvey
THERMOPOLIS
Schwabrow, John R.

BOGOTA—Alvarado, Benjamin
Bower, John O.
Brown, Silas C.
Butler, John W., Jr.
Daniel, Guy S.
Dykstra, Bouwe
Etherington, Thomas J.
Fichter, H. J.
Garwood, Roland
Graves, Allan Dexter
Guerrero, Alberto Lobo-
Hatfield, Willis Charles
Henry, Leonard W.
Henry, Schuyler B.
Hudson, W. T.
Lamon, Robert S.
McArthur, Donald
Miller, John B.
Miller, Robert P.
Oppenheim, Victor E.
Saville, C. William
Tabor, Lawrence L.
Trumpy, D.
Wheeler, Russell B.
Whipple, G. Leslie
Wilson, Joe G.
Wood, George R.
CUCUTA—Bowler, James W.
Bray, Vinton A.
Hubman, Carl W.
Schoonover, Jack Gardner
Vandenberg, Frederick E.
EL CENTRO
Acheson, Cyrus Harold
Barrow, Geoffrey
Colley, Bernard B.
HONDO—Aitken, W. Ernest

COSTA RICA

SAN JOSE—Gwinn, J. William
Link, Walter K.
Phillippi, W. H., Jr.
Wallis, William E

CUBA

HAVANA—Gravell, Donald W.
Klecker, John B.
Palmer, Robert H.

DOMINICAN REPUBLIC

CIUDAD TRUJILLO—Dohm, C. F.
Hunter, James W.
Lewis, J. Whitney

ECUADOR

GUAYAQUIL—Barrett, John F.
Beuck, W. F.
Durham, Charles A.
Fournier, F. L.
Loring, Ralph C.
Marks, Jay Glenn
Smith, Lorne A.
Ward, Dwight E.
Waring, W. W.
QUITO—Doxy, Jean Jacques
Goldschmid, Karl Theodor
Parsons, Harold Ewing
Tschopp, H. I.

EGYPT

CAIRO—Eicher, Donald B.
Foley, Edward J.
Haight, Harold W.
Lytel, Harvey M.
White, Kessack D.

ENGLAND

BERKSHIRE—Scott, Edwin Cooper
LONDON—Greig, Douglas A.
Howard, Arthur Henry
Lees, George M.
Lepper, G. W.
Milner, Henry Brewer
Noble, Arthur H.
Thompson, A. Beeby
MIDDLESEX—Hemmings, H.
Lovely, H. R.
Taverne, N. J. M.
SURREY—Hunter, Campbell M.
Illing, Vincent C.

FRANCE

HAUTE-GARONNE
Pomeyrol, Rene
PARIS—De Ceccatty, Pavans
Schlumberger, Marcel
Pellissier, Andre
VICHY—Damesin, L. C. F.

GERMANY

BERLIN—Bentz, A.
Stille, Hans
ESSEN-WERDEN—Mintrop, L.
WIEN—Bürgl, Hans

HAITI

PORT-AU-PRINCE
Kirk, Howard M.
Weidmann, Carl

INDIA

BOMBAY—Daniel, E. J.
CALCUTTA—Hoover, Malvern E

IRAN

TEHERAN
Karubian, Ruhollah Y.

IRAQ

BASRAH—Hotchkiss, Henry
KIRKUK—Henson, F. R. S.
QAIYARAH—Bennett, Johnson

ITALY

PALERMO—Fabiani, Ramiro
PARMA—Weidenmayer, Carl
ROME—Zuber, Stanislav

JAPAN

TOKYO—Iki, Tsunenaka
Uwatoko, Kunio

JAVA

BATAVIA—Brouwer, L. E. J.
Effinger, William L.
Hopper, Richard H.
Nelson, Richard N.

LIBAN

BEYROUTH—Birembaut, Arthur

MEXICO

COATZACOALCOS
Vázquez, Andrés López
MEXICO CITY
Alvarez, Manuel, Jr.
Arellano, A. R. V.
Garfias, Valentine R.
Ordoñez, Ezequiel
MONTERREY
Burbridge, C. E., Jr.
SALTILLO—Kane, William G.
TACUBAYA—Müllerried, F. K. G.
TAMPICO—Salas, G. P.

NETHERLANDS

AMSTERDAM—Doeglas, Kirk J.
BERGEN
van der Gracht, W. A. J. M.
THE HAGUE
Bauermann, Max K. H.
Dreher, Otto
Leyds, Louis W.
Schürmann, W. M. E.
van Gogh, F. A. A.

NEW ZEALAND

GISBORNE—Barnwell, George F.
Bossard, Leon
Collins, Burton Wallace
Thoms, Harold Wayne
Weymouth, A. Allen
NEW PLYMOUTH—Stinear, B. H.
PALMERSTON
Feldmeyer, Arthur E.
Nichols, Norval W.
TAIHAPE—Knight, Jack W.
WELLINGTON—Morgan, D. E.
Ongley, Montague

NICARAGUA

MANAGUA
Fagginer-Auer, Willem A.
PUERTO CABEZAS
Crickmay, Geoffrey W.
Davis, Horace C.
Nichols, Ivan K.

ONTARIO

OTTAWA—Beach, Hugh H.
Hume, George S.
TORONTO—Berwick, James D.
Hopkins, Oliver B.
Milstein, M.
Wheeler, Orby Clinton

PALESTINE

HAIFA—Browne, Richard Vernon
JERUSALEM—Wellings, F. E.

PAPUA

PORT MORESBY
Carey, S. Warren
Edwards, Allan K. M.
Gray, K. Washington
Greenham, Roy L.
Mott, William Dick
O'Driscoll, Eugene Patrick

PERSIAN GULF

BAHREIN ISLAND
Barger, Thomas C.
Bramkamp, R. A.
Langham, N. T.

PERU

CERRO DE PASCO
Jenks, William F.
LIMA—Iddings, Arthur
Fyfe, Douglas
Mackenzie, Andrew N.

NEGRITOS—Frizzell, Don L.
Bell, A. Lyndon

PHILIPPINE ISLANDS

CAVITE—Mortlock, Frank O.
MANILA—Corby, Grant W.
Newman, George H.
Ross, J. D.

PORTUGAL

LISBON—Mendelsohn, Clive A.

ROUMANIA

BUCHAREST—Reed, Lyman C.
Voitesti, Ion Popescu
CAMPINA—Hegwein, Walter H.
PLOESTI—Hlauscheck, H.

SCOTLAND

EDINBURGH
Brown, James Chapman
PITTENWEEM FIFE
Williamson, Thomas F.

ST. LUCIA

ST. LUCIA—Newhouse, Lester

SUMATRA

MEDAN—Dorn, Conrad L.
Fox, James P.
McCarver, Holland C.
Paap, Antonie
Storm, Alfred E.
Van Beveren, O. F.
PALEMBANG—Ayers, Floyd M.
Bard, Richards J.
McCobb, Harry W.
Surber, N. Courtney
Weisbord, Norman E.
Winkler, B. O.
PANGKALAN BRANDAN
Koch, Richard E.

SWITZERLAND

AARGAU—Gutzwiller, Otto
BASLE—Bernoulli, W.
Braendlin, E.
Erni, Arthur
Keller, Walter T.
Ritter, Ernest A.
Staehelin, Peter Karl
Vonderschmitt, Louis
LAUSANNE—Gagnebin, Elie A.
NEUCHATEL
Wasserfallen, Bernard
ZURICH—Frischknecht, Gustav
Kündig, Ernst

SYRIA

DEIR-EZ-ZOR—Badoux, Heli

THAILAND

DHONBURI—Sreshthaputra, Vija

TRINIDAD

FOREST RESERVE—Payne, A. L.
PALO SECO
Wilson, Cedric Clarke
POINTE-A-PIERRE
Barr, Kenneth William
Caudri, Cornelie Marguerite B.
Griffiths, J. C.
Hoenshell, David T.
Jowett, M. W.
Kugler, Hans G.
Renz, Hans Herman
Rogers, Harry Samuel
Rohr, Karl
Suter, Hans H.
POINT FORTIN—Haanstra, Ulco
Savage, John D.
Wait, S. T.

PORT OF SPAIN
Higgins, George Esmond
Kehrer, L.
Templeton, James Clark
SAN FERNANDO
Boutakoff, Nicholas
Penny, Frederick W.
SIPARIA—Scott, Gerald H.

TURKEY

ANKARA—Lokman, Kemal
Tasman, Cevat E.

URUGUAY

MONTEVIDEO
Vercesi, Daniel Rey

VENEZUELA

BARCELONA
Fowler, Charles W., Jr.
Funkhouser, H. J.
Hardin, Clifford G.
Hatheway, Joseph G.
Hedberg, Hollis D.
Johnson, Frank Walker
Lockett, George L.
Mahoney, Roger S.
Manger, G. Edward
Meszaros, W. A.
Pyre, Augustin
CARACAS—Aguerrevere, Pedro I.
Aguerrevere, Santiago E.
Andrews, Philip
Baird, C. A.
Boylan, Ebert E.
Brice, John W.
Brossard, Eugene E.
Champion, Joe A.
Conrad, Peter Paul
Crebbs, Chester M.
Dallmus, Karl F.
Davis, Irion G.
de Juana, Clemente Gonzalez
Floyd, Florin W.
Gerdes, C. H.
Huntley, Louis Guy
Jones, J. Byron
Judson, J. F.
Kaufmann, Godfrey F.
Kaye, M. Kamen
Kerstetter, Dale D.
Lee, Clarence L.
Lee, Herbert V.
Martin, Francis I.
Nance, James W.
Nolan, Philip Edward
Notestein, Frank B.
Poulin, John A.
Rivero, Manuel
Sherman, Roger H.
Stiles, Aden E.
Tipsword, Howard L.
West, Donald M.
Wilson, Thomas G.
Zuloaga, Guillermo
CARIPITO—Ackerman, E. Dumont
Borger, Harvey D.
Leoffler, Richard J.
Martin, Bethea A.
Regan, John H.
Sorrells, Warren D.
Tuohy, John D.
Winkler, Virgil
ESTADO GUARICO—Evanoff, John
LAGUNILLAS—Dickinson, George
MARACAIBO—Allen, John O.
Beckmann, Lawrence J.
Douglas, John G.
Freie, A. J.
Grimsdale, Thomas F.
Hamilton, James R.
Jopling, Don Winter
Martin, Rudolf
Nash, Howard F.
Netick, Joe
Pintea, Michael, Jr.
Pospisil, Frank J.
Ratway, Joseph
Refshauge, B. C.
Sawyer, Joseph Herbert
Schaub, Hans Peter
Sutton, Frederick A.
Tapp, Theodore L.

FINANCIAL STATEMENT FOR THE YEAR 1941

To the Executive Committee,
The American Association of Petroleum Geologists.

In continuation of our examinations in prior years we have examined the accounting records of THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS for the year ended December 31, 1941, and now present our report together with the following statements:

Exhibit

A	Statement of Financial Condition, December 31, 1941
B	Statement of Income for the year ended December 31, 1941

Schedule

*1	Statement of Investments, December 31, 1941
2	Statement of Income from Publications for the year ended December 31, 1941
3	Statement of General and Administrative Expenses for the year ended December 31, 1941

In connection with our examination, we reviewed the system of internal control and the accounting procedures of the Association and, without making a detailed audit of the transactions, have examined or tested accounting records of the Association and other supporting evidence, by methods and to the extent we deemed appropriate. Our examination was made in accordance with generally accepted auditing standards applicable in the circumstances and included all procedures which we considered necessary.

Publications on hand at December 31, 1941, were priced as follows: 1941 publications at cost; 1940 and prior years' publications at appraised values and a reserve provided for excessive quantities and old numbers, in accordance with a resolution adopted by the Executive Committee January 1, 1932.

Confirmation of certificates of securities in the custody of The New York Trust Company at December 31, 1941, was received directly from the custodian.

In our opinion, the accompanying statement of financial condition and related statement of income, supplemented by the supporting schedules, present fairly the position of THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS at December 31, 1941, and the results of its operations for the year in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(Signed) ARTHUR YOUNG & COMPANY, *Accountants and Auditors*

TULSA, OKLAHOMA
January 27, 1942

* Schedule 1 is not here published.

EXHIBIT A

STATEMENT OF FINANCIAL CONDITION, DECEMBER 31, 1941

ASSETS	*Total*	*General Fund*	*Publication Fund*	*Research Fund*
CURRENT ASSETS:				
Demand deposits—				
The First National Bank and Trust Company, Tulsa, Oklahoma	$ 20,245.79	$10,549.60	$ 9,227.62	$ 468.57
National Bank of Commerce, Tulsa, Oklahoma	795.75	795.75	—	—
TOTAL DEMAND DEPOSITS	$ 21,041.54	$11,345.35	$ 9,227.62	$ 468.57
Accounts receivable—				
Membership dues less reserve of $708.50	$ 708.50	$ 708.50	$ —	$ —
Advertising	998.00	998.00	—	—
Amount due from The New York Trust Company	728.78	605.83	122.95	—
Other accounts receivable less reserve of $452.84	547.72	322.71	225.01	—
TOTAL ACCOUNTS RECEIVABLE	$ 2,983.00	$ 2,635.04	$ 347.96	$ —
Accrued interest receivable less reserve of $520.41	$ 346.99	$ 271.45	$ 50.67	$ 24.87
Inventory of publications less reserve of $22,116.70 (see report)	$ 14,249.89	$ 9,234.96	$ 5,014.93	$ —
TOTAL CURRENT ASSETS	$ 38,621.42	$23,486.80	$14,641.18	$ 493.44
INVESTMENTS at market which is $10,086.30 less than cost	$ 74,161.75	$57,198.83	$14,698.65	$2,264.27
FURNITURE AND FIXTURES less reserve of $4,141.41	$ 1.00	$ 1.00	$ —	$ —
DEFERRED CHARGES:				
Printing in progress	$ 5,302.65	$ 934.31	$ 4,368.34	$ —
Winnebago English Finish paper for special publications	$ 1,015.00	—	1,015.00	—
Other deferred charges	81.51	81.51	—	—
TOTAL DEFERRED CHARGES	$ 6,399.16	$ 1,015.82	$ 5,383.34	$ —
TOTAL ASSETS	$119,183.33	$81,702.45	$34,723.17	$2,757.71

LIABILITIES AND SURPLUS	*Total*	*General Fund*	*Publication Fund*	*Research Fund*
CURRENT LIABILITIES:				
Accounts payable	$ 2,759.76	$ 2,759.76	$ —	$ —
Accrued printer's charges	4,702.42	334.08	4,368.34	—
TOTAL CURRENT LIABILITIES	$ 7,462.18	$ 3,093.84	$ 4,368.34	$ —
DEFERRED INCOME:				
Memberships and subscriptions—				
Active memberships	$ 7,415.04	$ 7,415.04	$ —	$ —
Associate memberships	1,125.40	1,125.40	—	—
Subscriptions to Bulletin	2,193.75	2,193.75	—	—
	$ 10,734.19	$10,734.19	$ —	—
Advertising	432.50	432.50	—	—
TOTAL DEFERRED INCOME	$ 11,166.69	$11,166.69	$ —	$ —
SURPLUS:				
Balance, December 31, 1940	$ 97,387.55	$66,721.88	$26,650.82	$4,014.85
Transferred from General Fund to Research Fund	—	*—1,000.00*	—	1,000.00
	$ 97,387.55	$65,721.88	$26,650.82	$5,014.85
Net income—*loss* for the year ended December 31, 1941 (Exhibit B)	3,166.91	1,720.04	3,704.01	*—2,257.14*
Balance, December 31, 1941	$100,554.46	$67,441.92	$30,354.83	$2,757.71
CONTINGENT LIABILITIES:				
All known liabilities of the Association at December 31, 1941, were recorded in the accounts and no litigation was pending at that date.				
TOTAL LIABILITIES AND SURPLUS	$119,183.33	$81,702.45	$34,723.17	$2,757.71

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

EXHIBIT B

STATEMENT OF INCOME FOR THE YEAR ENDED DECEMBER 31, 1941

	Members	Annual Dues	Total		General Fund		Publication Fund		Research Fund	
OPERATING INCOME:										
Dues for current period—										
Active memberships	2,892	$10.00		$28,920.00		$28,920.00		$ —		$ —
Associate memberships—										
Less than three years	565	6.00	$3,390.00		$3,390.00		$ —		$ —	
Three to six years	133	8.00	1,064.00		1,064.00		—		—	
Over six years	33	10.00	330.00	4,784.00	330.00	4,784.00	—	—	—	—
				$33,704.00		$33,704.00		$ —		$ —
Less: Transferred to "Income from Publications" ($6.00 per member)				21,738.00		21,738.00		—		—
				$11,966.00		$11,966.00		$ —		$ —
Net income from publications (Schedule 2)				9,230.77		6,352.12		2,878.65		—
				$21,196.77		$18,318.12		$2,878.65		$ —
GENERAL AND ADMINISTRATIVE EXPENSES (Schedule 3)				16,641.65		16,621.65		20.00		—
				$ 4,555.12		$ 1,696.47		$2,858.65		$ —
OTHER INCOME:										
Income from investments			$2,641.14		$2,052.97		$509.90		$ 78.27	
Net profit on sale of investments			450.00		450.00		—		—	
Recovery of accounts previously charged off			333.35		333.35		—		—	
Convention revenue—net			632.84		632.84		—		—	
Miscellaneous			233.78	4,291.11	233.78	3,702.94	—	509.90	—	78.27
				$ 8,846.23		$ 5,399.41		$3,368.55		$ 78.27
INCOME DEDUCTIONS:										
Adjustment of stated value of investments to market			$2,352.66		$2,579.37		$−335.46		$ 108.75	
Research projects—										
Geological map of North America			1,000.00		—		—		1,000.00	
Bass-Neumann Oil Analysis			1,025.13		—		—		1,025.13	
Tectonic map of North America			75.29		—		—		75.29	
Waldschmidt's Core Analysis			31.35		—		—		31.35	
Time of Origin and Accumulation of Petroleum			78.67		—		—		78.67	
Revelle-Shepard Oceanography			16.22		—		—		16.22	
Donation to Society of Economic Paleontologists and Mineralogists			1,100.00	5,679.32	1,100.00	3,679.37	—	−335.46	—	2,335.41
NET INCOME—LOSS				$ 3,166.91		$ 1,720.04		$3,704.01		$−2,257.14

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

SCHEDULE 2

SCHEDULE 2

STATEMENT OF INCOME FROM PUBLICATIONS FOR THE YEAR ENDED DECEMBER 31, 1941

	Total		*General Fund*		*Publication Fund*	
OPERATING INCOME:						
Dues transferred		$21,738.00		$21,738.00		$ —
Bulletin subscriptions		4,650.15		4,650.15		—
Advertising—net		8,271.13		8,271.13		—
Sales of bound volumes and special publications—						
Bound volumes of Bulletin	$ 2,288.00		$ 2,288.00		$ —	
Back numbers of Bulletin	895.18		895.18		—	
Possible Future Oil Provinces of the United States and Canada	1,165.66		1,165.66		—	
Origin of Oil	309.00		309.00		—	
Stratigraphic Type Oil Fields	1,612.41		—		1,612.41	
Source Beds of Petroleum	779.80		—		779.80	
Recent Marine Sediments	710.00		—		710.00	
Geology of Natural Gas	336.54		—		336.54	
Gulf Coast Oil Fields	327.20		—		327.20	
Miocene Stratigraphy of California	220.00		—		220.00	
Geology of the Tampico Region	173.30		—		173.30	
Tectonic Map of Southern California	22.31		—		22.31	
Regional Cross Sections	123.52		123.52		—	
Comprehensive Index	15.20		15.20		—	
Other publications	121.55	9,099.67	119.95	4,916.51	1.60	4,183.16
TOTAL INCOME		$43,758.95		$39,575.79		$4,183.16
COSTS AND EXPENSES:						
Proportion of manager's salary	$ 3,750.00		$ 3,750.00		—	
Editorial salaries	3,960.00		3,960.00		—	
Printing Bulletins	18,668.26		18,668.26		—	
Engraving	2,648.06		2,648.06		—	
Special insert charges	392.63		392.63		—	
Stencil corrections and mailing	227.20		227.20		—	
Bulletin mailing and express	1,216.54		1,216.54		—	
Copyright fees	24.00		24.00		—	
Reprints	176.07		176.07		—	
Binding Volume XXIV	599.40		599.40		—	
Prints of Regional Cross Sections	85.33		85.33		—	
Cost of printing Possible Future Oil Provinces of the United States and Canada	827.18		827.18		—	
Cost of printing Origin of Oil	257.81		257.81		—	
Source Beds of Petroleum	16.35		—		16.35	
Stratigraphic Type Oil Fields	96.43		—		96.43	
Other publications—freight, express and postage	49.81		—		49.81	
Miscellaneous	123.89		100.99		22.90	
	$33,118.96		$32,933.47		$ 185.49	
Add: Inventory decrease	1,409.22		290.20		1,119.02	
TOTAL COSTS AND EXPENSES		34,528.18		33,223.67		1,304.51
NET INCOME FROM PUBLICATIONS		$ 9,230.77		$ 6,352.12		$2,878.65

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

SCHEDULE 3

STATEMENT OF GENERAL AND ADMINISTRATIVE EXPENSES FOR THE YEAR ENDED DECEMBER 31, 1941

GENERAL FUND:	
Proportion of manager's salary	$ 3,750.00
Clerical salaries	5,770.13
Postage	2,116.43
Office rent	1,600.00
Office supplies and expenses	467.70
Printing and stationery	193.49
Telephone and telegraph	349.61
Insurance	210.14
Investment counsel	400.00
Audit fee	300.00
Freight and express	219.68
Bad debts	776.82
Depreciation of furniture and fixtures	75.75
Traveling expense	180.40
Miscellaneous	211.50
	$16,621.65
PUBLICATION FUND:	
Miscellaneous	$ 20.00
TOTAL GENERAL AND ADMINISTRATIVE EXPENSES	$16,641.65

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

FINANCIAL STATEMENT, DIVISION OF PALEONTOLOGY AND MINERALOGY, FOR THE YEAR 1941

To the Council,
Society of Economic Paleontologists and Mineralogists.

In continuation of our examinations in prior years we have examined the accounting records of the SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS for the year ended December 31, 1941, and now present our report together with the following statements:

Exhibit

A	Statement of Financial Condition, December 31, 1941
B	Statement of Income for the year ended December 31, 1941

Schedule

1	Statement of Receipts and Disbursements for the year ended December 31, 1941

In connection with our examination, we reviewed the system of internal control and the accounting procedures of the Society and, without making a detailed audit of the transactions, have examined or tested accounting records of the Society and other supporting evidence, by methods and to the extent we deemed appropriate. Our examination was made in accordance with generally accepted auditing standards applicable in the circumstances and included all procedures which we considered necessary.

Inventory of publications represents aproximately 26,900 Journals (exclusive of Journals in excess of complete sets for issues prior to 1941) including certain issues printed at the expense of the Paleontological Society for the years 1935 to 1941, inclusive, stated at appraised values of fifty cents each for Journals printed prior to 1941 or cost to either the SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS or the PALEONTOLOGICAL SOCIETY for Journals printed in 1941. The SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS has agreed to distribute a portion of its income to the Paleontological Society; the amount accruing to the latter for the year 1941 amounted to $358.38.

In our opinion the accompanying statement of financial condition and related statement of income present fairly the position of the SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS at December 31, 1941, and the results of its operations for the year, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(Signed) ARTHUR YOUNG & COMPANY, *Accountants and Auditors*

TULSA, OKLAHOMA
January 27, 1942

EXHIBIT A

STATEMENT OF FINANCIAL CONDITION
DECEMBER 31, 1941

ASSETS

CURRENT ASSETS:		
Demand deposits—		
The First National Bank and Trust Company, Tulsa, Oklahoma	$4,273.84	
National Bank of Commerce, Tulsa, Oklahoma	30.46	$ 4,304.30
Savings deposit—		
The First National Bank and Trust Company, Tulsa, Oklahoma		2,165.88
Accounts receivable—		
Printed matter less reserve of $84.00		14.02
TOTAL CURRENT ASSETS		$ 6,484.20
INVENTORY OF PUBLICATIONS—see report		14,081.62
FURNITURE AND FIXTURES	$ 482.60	
Less: Reserve for depreciation	192.46	290.14
DEFERRRED CHARGES		512.04
TOTAL ASSETS		$21,368.00

LIABILITIES AND SURPLUS

CURRENT LIABILITIES:		
Accounts payable		$ 328.70
Accrued printers' charges		512.04
Amount due to Paleontological Society		358.38
TOTAL CURRENT LIABILITIES		$ 1,199.12
DEFERRED INCOME:		
Subscriptions to Journals	$1,228.20	
Membership dues for 1942 and 1943	572.00	1,800.20
SURPLUS:		
Balance, December 31, 1940	$17,296.79	
Net income for the year ended December 31, 1941 (Exhibit B)	1,071.89	
Balance, December 31, 1941		18,368.68
CONTINGENT LIABILITIES:		
All known liabilities of the Society at December 31, 1941 were recorded in the accounts and no litigation was pending at that date.		
TOTAL LIABILITIES AND SURPLUS		$21,368.00

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

EXHIBIT B

STATEMENT OF INCOME FOR THE YEAR ENDED DECEMBER 31, 1941

OPERATING INCOME:		
Dues and subscriptions—		
Journals of Paleontology and Sedimentary Petrology		$ 840.00
Journal of Paleontology		2,887.90
Journal of Sedimentary Petrology		848.20
		$4,576.10
Sales of back numbers—		
Journal of Paleontology	$663.50	
Journal of Sedimentary Petrology	225.85	889.35
Sales of plates and reprints		202.73
Advertising		62.46
		$5,730.64
Less: Proportion of income accrued to Paleontological Society		358.38
		$5,372.26
COSTS AND EXPENSES:		
Cost of printing—		
Journal of Paleontology	$3,040.53	
Journal of Sedimentary Petrology	993.36	
	$4,033.89	
Clerical salaries	720.00	
Office rent	300.00	
Postage and mailing	279.61	
Audit fee	100.00	
Office supplies and expenses	134.62	
Bad debts	84.00	
Depreciation	48.26	
Other costs and expenses	97.25	
	$5,797.63	
Less: Increase in inventory of publications	357.78	5,439.85
		$ *−67.59*
NON-OPERATING INCOME:		
Donation from The American Association of Petroleum Geologists	$1,100.00	
Recovery of accounts previously charged off	28.00	
Interest on savings deposit	11.48	1,139.48
NET INCOME		$1,071.89

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

SCHEDULE 1

STATEMENT OF RECEIPTS AND DISBURSEMENTS FOR THE YEAR ENDED DECEMBER 31, 1941

DEMAND DEPOSITS, DECEMBER 31, 1940			$ 4,705.05
RECEIPTS:			
Membership dues and subscriptions—			
Year 1941—			
Journals of Paleontology and Sedimentary Petrology	$ 464.00		
Journal of Paleontology	1,743.68		
Journal of Sedimentary Petrology	514.00	$2,721.68	
Years 1942 and 1943—			
Journals of Paleontology and Sedimentary Petrology	$ 288.00		
Journal of Paleontology	1,130.40		
Journal of Sedimentary Petrology	344.40	1,762.80	
Sales of back numbers—			
Journal of Paleontology	$ 507.20		
Journal of Sedimentary Petrology	122.60	629.80	
Sales of plates and reprints		186.58	
Accounts receivable		267.34	
Donation from The American Association of Petroleum Geologists		1,100.00	
Miscellaneous		267.03	6,935.23
			$11,640.28
DISBURSEMENTS:			
Printing expenses—			
Journal of Paleontology	$2,298.95		
Journal of Sedimentary Petrology	1,093.70		
Engraving Journal of Paleontology	651.99	$4,044.64	
Postage and mailing		145.11	
Office rent		300.00	
Clerical salaries		720.00	
Audit fee		100.00	
Payment to Paleontological Society		313.64	
Editorial salaries		300.00	
Refund on subscriptions		41.66	
Office supplies and expenses		42.67	
Transfer to savings account		1,100.00	
Miscellaneous		228.26	7,335.98
DEMAND DEPOSITS, DECEMBER 31, 1941			$ 4,304.30

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

CODE OF ETHICS OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

OBJECT. The object of this Association is to promote the science of geology, especially as it relates to petroleum and natural gas; to promote the technology of petroleum and natural gas and to encourage improvements in the methods of exploring for and exploiting these substances; to foster the spirit of scientific research amongst its members; to disseminate facts relating to the geology and technology of petroleum and natural gas; to maintain a high standard of professional conduct on the part of its members; and to protect the public from the work of inadequately trained and unscrupulous men posing as petroleum geologists (Constitution, Article II.)

ARTICLE I. GENERAL PRINCIPLES

SECTION 1. The practice of petroleum geology is a profession. It is the duty of those engaged in it to be guided by the highest standards of professional conduct and to subordinate reward and financial gain thereto.

SEC. 2. The confidence of the public and of the oil industry can be won and held only by the practice of the highest ethical principles.

SEC. 3. Honesty, integrity, fairness, candor, fidelity to trust, inviolability of confidence, and conduct becoming a gentleman are incumbent upon every member of the Association.

ARTICLE II. RELATION OF GEOLOGIST TO PUBLIC AND PROFESSION

SECTION 1. A geologist should avoid and discourage sensational, exaggerated, and unwarranted statements, especially those that might induce participation in unsound enterprises.

SEC. 2. A geologist should not knowingly permit the publication of his reports or maps for the purpose of raising funds without legitimate and sound development in view.

SEC. 3. A geologist may accept for his services in the making of a report an interest in the property reported on, but it is desirable that the report state the fact of the existence of the interest.

SEC. 4. A geologist should not give an opinion or make a report without being as fully informed as might reasonably be expected, considering the purpose for which the information is desired. The opinion or report should make clear the conditions under which it is made.

SEC. 5. A geologist may publish simple and dignified business, professional, or announcement cards, but should not solicit business by other advertisements, or through agents, or by furnishing or inspiring exaggerated newspaper or magazine comment. The most worthy advertisement is a well merited reputation for professional ability and fidelity. This can not be forced, but must be the outcome of character and conduct.

ARTICLE III. RELATION OF GEOLOGISTS TO EMPLOYER

SECTION 1. A geologist should protect, to the fullest extent possible, the interests of his employer so far as consistent with the public welfare and his professional obligations.

SEC. 2. A geologist who finds that his obligations to his employer conflict with his professional obligations should notify his employer of that fact. If the objectionable condition persists, the geologist should sever his connection with his employer.

SEC. 3. A geologist should not allow himself to become or remain identified with any enterprise of questionable character.

SEC. 4. A geologist should make known to his prospective employer any oil or gas interest which he holds in the region of his prospective employment.

SEC. 5. A geologist, while employed, should not directly or indirectly acquire any present or prospective oil or gas interest without the express consent of his employer.

SEC. 6. A geologist retained by one client, should, before accepting engagement by another, notify them of this affiliation, if in his opinion the interests might conflict.

SEC. 7. A geologist who has made an investigation for a client should not, without the client's consent, seek to profit from the economic information thus gained, or report on the same subject for another client, until the original client has had full opportunity to act on the report.

SEC. 8. A geologist should not accept direct or indirect compensation from both buyer and seller, without consent of both parties; or from parties dealing with his employer without the employer's consent.

SEC. 9. A geologist should observe scrupulously the rules, customs, and traditions of his employer as to the use or giving out of information or the acquisition of interests, both while employed and thereafter; and, except as permitted by such rules, customs, and traditions or by the consent of the employer, he should not seek to profit directly or indirectly from the economic information gained while so employed.

SEC. 10. A geologist employed by a State geological survey should not permit private professional work or the holding of private mineral interests in the state to interfere with his duty to the public or to lessen the confidence of the public in the survey. The preferable course is to avoid such private work and interests.

SEC. 11. A geologist should not divulge information given him in confidence.

ARTICLE IV. RELATION OF GEOLOGIST TO OTHER GEOLOGISTS

SECTION 1. A geologist should not falsely or maliciously attempt to injure the reputation or business of a fellow geologist.

SEC. 2. A geologist should not knowingly compete with a fellow geologist for employment by reducing his customary charge.

SEC. 3. A geologist should give credit for work done to those, including his assistants, to whom credit is due.

ARTICLE V. DUTY TO THIS ASSOCIATION

SECTION 1. Every member of the Association should aid in preventing the election to membership of those who lack moral character or the required education and experience.

SEC. 2. A member of this Association who has definite evidence of the violation of the established principles of professional ethics by another should report the facts to the executive committee.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 3 (MARCH, 1942), PP. 513–517, 1 FIG.

Memorial

MORGAN EVAN ROBERTS
(1894–1941)

The close associates of Morgan E. Roberts were shocked on the morning of December 31, the last day of his 47th year, when, because of a heart attack, he failed to awaken after having fallen asleep while reading. His excellent natural physique, further developed and hardened by the years of field work, enabled him to possess a robust appearance to the very last.

Morgan's paternal grandfather, Hugh Roberts, a Welshman, settled in Lewis County near Booneville in upper New York state during the year 1848. His son, David Evan Roberts, attended Cornell University where he met and later married Kate Rhodes, of English and Holland Dutch ancestory who had settled in the vicinity of Kingston, New York, but whose immediate family had migrated to western Wisconsin. The call of the West was strong and it took him to the University of Michigan where he completed his work in Law as a member of the class of 1881. With a firm faith in the future of the head of the lakes country, it was a natural step for the young attorney and his wife to select Superior, Wisconsin, then just a village, as the site of their life work. Here they made their home and their children, Hugh, Helen, John, Jessie, Florence, Morgan, David, and Arthur were born.

In addition to the usual public school education, each of the boys served an apprenticeship in Judge Roberts office. Morgan was graduated from the Superior Normal school in 1914 and his first summer employment was with Colonel John C. Greenway of the Oliver Iron Mining Company in the year 1911. As Morgan grew and his interests widened, his first vivid contacts with the outside world were the ore boats moving their loads of red earth from the head of the lakes to the great iron centers to the south. They fascinated him as they appeared on the blue horizon, arrived in port, loaded, and then departed whence they had come. He shipped as a deck hand on many of these when only a boy and so experienced the thrill of arriving in strange ports and seeing strange lands. He never quite forgot his boyhood plans of shipping on the tramp steamers which circle the globe.

All of Morgan's experiences during these early years were not confined to the mines and the lakes: several summers were spent with the engineering crews of the Northern Pacific Railroad working westward through Minnesota and the Dakotas.

In the year 1917 he received his degree of mining engineer from the University of Wisconsin and joined the Canadian Geological Survey, then engaged in making a mineral survey of the provinces. This work was interrupted by the entry of the United States in the World War I and Morgan entered the services of this country as a member of the U. S. Engineering Corps, where he was commissioned a second lieutenant. He was soon sent overseas and saw duty as regimental supply officer of the 60th Engineers in the Dijon and Neufchateau areas of northeastern France, where he remained until the end of the conflict. Before returning to the United States he spent several months taking advanced work in geology at Oxford University. After returning from these experiences he set out for Texas, where his brother John was connected

with the Bureau of Economic Geology and later with The Texas Company. During Morgan's experiences here he became connected with the geological department of the Pierce Oil Corporation, which position he relinquished in



MORGAN EVAN ROBERTS

1920 in order to accept an offer from the Whitehall Petroleum Corporation Ltd. of London to undertake geological exploration in one of many countries in which work was being contemplated. He returned to London and was assigned the task of conducting a geological reconnaissance throughout portions of French and Spanish Morocco.

In Morocco, Morgan established headquarters in Fez and so opened a new chapter in his life. The organization of a self-contained reconnaissance unit, traveling by horse and pack train, required a unique combination of equipment and personnel drawn from local and imported sources. The French and Spanish languages commonly spoken in and around the walled cities of Fez, Meknes, Rabat, Larache, and Marrakesh were left behind when the party took to the trails leading through the open country and rugged hinterland where, save for the French military posts, Arabic and the Berberdialects were the languages of the land. The "Zone of Insecurity," that area between the fighting fronts and the areas considered safe for civilians, held the key to the desired geological information. Morgan's experiences here, if set down, would make many chapters of fascinating reading. His loyalty to his staff inspired the return of loyalty to the leader. His faithful Arab, Abdeslaam, who each morning faced the east to pray to his Mohammed, would, that same day, have given his life to protect that of his Christian employer who, in his daily living, demonstrated so well a code of ethics that conflicted with neither belief. Morgan's desire to see the other side of just one more mountain before turning back took him to and beyond the fighting front, to the snow-covered Rif Mountains, deep into the highlands of the forbidden Atlas, and into the sacred city of Mouli Idris, where Christians were not welcomed. The near-by ruins of the ancient Roman city of Volubilis, with a portion of its aqueduct still functioning, aroused in him great admiration for those virile, early engineers, and as he pondered the Latin inscriptions on the public building he voiced stinging self-condemnation for having spent so little effort on the language when he had been exposed to it. He was engrossed not only in the geological studies of the area, but with his usual diversity of interest, made keen observations concerning the geography, the history, the architecture, the people, and even the flowers which carpeted the countryside during the early spring.

During the year 1922 Morgan returned to London and was assigned a detail project along the Cazones River in the Palma Sola district of Mexico, working for the Cia. Mexicana de Petroleo "El Aguila." After completion of this jungle project, subsequent assignments brought him to northern Mexico and the Rio Grande Embayment south of the river. It was in the year 1924 that he accepted an offer from The Pure Oil Company to join its geological staff, a connection that continued until his untimely death. Back in the state of Texas again, his first task was to continue the studies of the Rio Grande Embayment north of the river and throughout southern Texas. Then a succession of assignments—East Texas, the Texas Panhandle, West Texas, and Central Texas—came to him. Few men have been favored with such wide opportunities for experience in both surface and subsurface investigations and few have concentrated more diligently. After a year spent in the states of California and Wyoming, he was returned to western Texas and eastern New Mexico where he was made district geologist with officers in San Angelo, Odessa, Midland, and finally in Fort Worth. He was inspired by the grandeur of the area in which he worked—the magnificent distances, the call of the shimmering mountains on the horizon during the day and their calm serenity in the early morning light. He was appreciative of even the crisp bracing air of these highlands. The subtle and sometimes shocking changes in the stratigraphy and structure presented challenges which he eagerly accepted. He always retained some of the traits of a mining engineer and combined these well with his geological training and experience.

Even though he created many masterly reports on the broad features of his subject Morgan was reluctant to write for publication. He was scrupulously conscious that the information in his possession was not his alone but rather the property of the organization of which he was only a part. Further, he was keenly aware that the subject with which he was dealing was very much alive and growing,—that each day brought new control and each new point carried the hope of profound revelation that would sharply alter geological thought; therefore, he was loth to freeze his conceptions of the problem so early in its development. It was in conference or over the tea cups that his influence was felt most keenly and the results of his years of penetrating research and grinding persistency shone forth. He inspired many to investigations of special problems and to publication but even his own tribute to his close friend, George Alfred Kroenlein[1] was written anonymously.

His broad interests and wide experiences, along with his insatiable appetite for reading, enabled him to contribute color and vital facts to any discussion. He early realized the advantages of fellowship resulting from membership in the American Association of Petroleum Geologists and became a member in the year 1920. He was also a member of the American Institute of Mining Engineers, the American Geographical Society, the Fort Worth Geological Society, the West Texas Geological Society, and the Fort Worth Chess Club.

During his later years of subsurface work he was never completely separated from field work. Week-ends were spent with friends or alone on camping trips in the mountains where some of the formations with which he worked during the week could be observed intact on the surface. Both in summer and winter his swimming suit was standard equipment of his car. His reputation as an able chess player spread throughout the area and on his arrival in Fort Worth he was promptly made a member of the city team.

The geological profession has lost a valuable and unique character from its ranks, one with a keen sense of humor and a spirit of good fellowship, one who was for himself a hard master, but who, in his relations with others showed only tender consideration of their thoughts and feelings and always extended a helping hand to a comrade whose path was rough.

His last resting place is among the northern pines on the shore of his beloved Lake Superior near the city of his birth.

ROBERT F. IMBT

FORT WORTH, TEXAS
January 21, 1942

[1] Memorial, *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 8 (August, 1940), pp. 1521–23.

JAMES WALKER CAIN, JR.
(1917–1941)

James Walker Cain, Jr., was born on September 24, 1917, in Houston, Texas, and died on July 15, 1941, in Houston, of infantile paralysis, after spending approximately a week in an iron lung in Memorial Hospital.

He is survived by his parents, Mr. and Mrs. James Walker Cain, of Houston, Texas, and a brother, Dixon Cain, of Shreveport, Louisiana.

Walker attended The University of Texas from 1936 to 1940. He was graduated with a bachelor of science degree in geology, June, 1940. He be-

longed to the Kappa Sigma social fraternity and Sigma Gamma Epsilon honorary geological fraternity. He was a member of Christ Episcopal Church of Houston. He joined The American Association of Petroleum Geologists in October, 1940. His sponsors for associate membership were George W. Carr, G. A. Berg, and Chester Sappington. He was an associate member until the time of his death.

Shortly after completing his studies at The University of Texas he accepted a position with The General Geophysical Company. Most of the time spent with this company was in southern Louisiana and Mississippi.

One of Walker's outstanding characteristics was his faculty for making and keeping friends. During his short time in the geophysical field he had gained the friendship and admiration of his many associates.

His many friends deeply regret the death of this young man, whose rapid progress in his chosen profession gave such good promise for a wonderful future.

CHESTER SAPPINGTON

HOUSTON, TEXAS
January 12, 1942

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 26, NO. 3 (MARCH, 1942), PP. 518-532.

AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

A. C. ELLIOTT may be addressed at Box 403, Pilot Point, Texas. His work with the Shell Oil Company, Inc., ended on February 15, and he reported as a First Lieutenant of Infantry Reserve at Fort Benning, Georgia.

DELMAR R. GUINN of the Cities Service Oil Company, has been transferred from Hobbs, New Mexico, to Tyler, Texas.

H. M. LYTEL may be addressed in care of the Socony-Vacuum Oil Company, 62 Sharia Ibrahim Pasha, Cairo, Egypt.

The Society of Economic Geologists, on the recommendation of a committee consisting of R. S. BUTLER, T. S. LOVERING, and ADOLPH KNOPF, chairman, has awarded its Penrose Medal to Professor WILLIAM H. EMMONS, of the University of Minnesota, in recognition of his outstanding contributions to the science of economic geology. The presentation was made on February 10, 1942, at the annual dinner of the Society in New York.

O. C. OLSON has accepted a position with the Oil and Gas Division of the Texas Railroad Commission as a petroleum engineer.

HELEN TAPPAN LOEBLICH is now employed as instructor in geology at Tulane University, New Orleans, Louisiana, the position formerly held by her husband, ALFRED R. LOEBLICH, who is now serving as a First Lieutenant, Field Artillery Replacement Training Center, Fort Bragg, North Carolina. Mrs. Loeblich is continuing work on their joint research problem concerning Lower Cretaceous Foraminifera.

R. H. BECKWITH talked on "Trace-Slip Faults" before the Rocky Mountain Association of Petroleum Geologists at Denver, Colorado, February 16, 1942.

GUSTAVE E. ARCHIE, of the Shell Oil Company, Inc., Houston, talked before the Houston Geological Society, February 12, on "The Electrical Resistivity Log as an Aid in Determining Some Reservoir Characteristics."

A. R. FOSDICK, recently with the W. P. Luse Petroleum Company, is geologist for the Southwood Oil Company, Dallas, Texas.

ROBERT GROSJEAN has left the Magnolia Petroleum Company, and is now connected with Brown and Wheeler, Inc., Houston, Texas.

U. R. LAVES, who has been in consulting geological work at Ada, Oklahoma, several years, is chief of the oil-field equipment unit of the machinery section of the Office of Price Administration, Washington, D. C.

RICHARD V. HUGHES has resigned his position as chief geologist of the Tropical Oil Company at Barranca Bermeja, Colombia, and has accepted appointment as a principal petroleum development analyst in the Office of the Petroleum Coordinator for National Defense at Washington, D. C. His address is 2134 G. Street, N. W.

MICHAEL T. HALBOUTY, consulting geologist and petroleum engineer, Houston, Texas, has been called to active duty as a captain in the army, and is temporarily stationed at Fort Benning, Georgia.

LYMAN C. DENNIS, of The Pure Oil Company, has been transferred from Clay City, Illinois, to Jackson, Mississippi, as district geologist there, replacing JOHN BERG, who has been moved to Shreveport, Louisiana, in a similar position.

RALPH E. TAYLOR has changed his address from the Cuban Mining Company, El Cristo, Cuba, to Box 1520, New Orleans, Louisiana.

STANLEY B. WHITE, geologist with the Ohio Oil Company at Tulsa, Oklahoma, for many years, has been moved to the company's offices at Findlay, Ohio. MAURICE R. TEIS, formerly with the Home Stake Companies, and T. V. FROST, recently with the Mid-Continent Petroleum Corporation, have been added to the geological staff of the Ohio at Tulsa.

ED BLOESCH, consulting geologist at Tulsa, has an article in the *Oil and Gas Journal* of February 12 on "Cost of Producing Oil."

H. P. STOLZ, of Stanley and Stolz, consultants, Los Angeles, California, recently elected chairman of the Petroleum Division of the American Institute of Mining and Metallurgical Engineers, is a lieutenant commander assigned to the Office of Inspector of Naval Petroleum Reserves in California as assistant inspector.

MAX W. BALL, president of Abasand Oils, Ltd., Waterways, Canada, is chairman of the Northern Branch of the Canadian Institute of Mining and Metallurgy, which recently met at Edmonton, Alberta.

RUSSELL S. KNAPPEN, assistant to the vice-president of the Gulf Oil Corporation at Tulsa, recently spoke before the Fort Worth, Texas, Geological Society on "Military Geology."

GEORGE SAWTELLE, president of the Kirby Petroleum Company, Houston, Texas, is chairman of the Houston Chamber of Commerce water-supply committee.

OSCAR HATCHER, recently consulting geologist at Ada, Oklahoma, has joined the geological staff of the Mid-Continent Petroleum Corporation at Tulsa as subsurface geologist.

H. H. BRADFIELD, paleontologist with The Texas Company at Fort Worth, Texas, spoke on "Pennsylvanian Stratigraphy and Correlations in North Texas," before the North Texas Geological Society at Wichita Falls, Texas, February 11.

W. B. Heroy, of the Pilgrim Exploration Company, Houston, Texas, is president-elect of the Society of Economic Geologists.

LESLIE C. CASE, of the Gulf Oil Corporation, Tulsa, and leader of the A.A.P.G. research committee group on oil-field waters, spoke before the Tulsa Geological Society, February 16, on "Oil-Field Waters."

RAY E. CLAIBORNE, recently geologist with The California Company, Houston, Texas, has accepted appointment in the office of the Securities and Exchange Commission, oil unit, at Tulsa, Oklahoma.

E. G. DAHLGREN, recently in the Office of the Petroleum Coordinator at Washington, D. C., is with the Interstate Oil Compact Commission, Oklahoma City office.

VICTOR E. EKHOLM, consulting geologist of Dallas, Texas, has gone to La Paz, Bolivia, as general manager and chief geologist for the Bolivian Government, now operating the oil properties purchased from the Standard Oil Company of New Jersey.

THOMAS C. WILSON is with the Venezuelan Atlantic Refining Company, Apartado 968, Caracas, Venezuela. He was recently at Managua, Nicaragua.

J. BRIAN EBY, consultant, and T. I. HARKINS, of the Independent Exploration Company, talked before the Houston Geological Society, February 26, on "Geophysical History of Darrow Dome, Ascension Parish, Louisiana."

L. W. STORM, of the Schlumberger Well Surveying Corporation, gave "A Résumé of Current Opinion on Larger Features of Gulf Coast Sedimentation," before the West Texas Geological Society at Midland, February 23.

FRITZ L. AURIN, of the Southland Royalty Company, Fort Worth, Texas, spoke before the Shreveport Geological Society at Shreveport, Louisiana, March 2, on "The Relationship of the Geological Profession to the War Effort." Aurin is chairman of the A.A.P.G. committee on National Service.

C. S. LAVINGTON, of the Continental Oil Company, Denver, Colorado, spoke before the Rocky Mountain Association of Petroleum Geologists, at Denver, March 2, on "Is There an Unconformity between the Denver Formation and the Dawson Arkose?"

The Heiland Research Corporation, C. A. HEILAND, president, announces the opening of its newly completed building at 130 East Fifth Street, Denver, Colorado, where its offices, laboratory, and factory are now located.

RICHARD J. RUSSELL, professor of geology, Louisiana State University, Baton Rouge, addressed the members of the New Orleans Geological Society, February 2, on "Loess Deposits of the Lower Mississippi River Valley."

New officers of the Association of American State Geologists, elected at the annual meeting in Washington, D. C., February 13–14 are: president, PAUL H. PRICE, State geologist of West Virginia; vice-president, EARL K. NIXON, director of the State Department of Geology and Mineral Industries of Oregon; and secretary-editor, ROBERT H. DOTT, director of the Oklahoma Geological Survey.

JACK F. DOUGHERTY has resigned from the Federal Power Commission, Fort Worth regional office, to join the geological staff of the Amarillo district office of the Phillips Petroleum Company.

C. C. HEMSELL, of the Columbian Fuel Corporation, Amarillo, Texas, spoke on "The Lower Paleozoic Sediments of Cimarron County, Oklahoma," at a recent meeting of the Panhandle Geological Society, at Amarillo.

FRED P. SHAYES, of the Union Producing Company, Beeville, Texas, presented a paper on "Geology of the Agua Dulce and Stratton Fields in Western Nueces County, Texas," before the South Texas Geological Society, at Corpus Christi, February 27.

JOHN M. HILLS, consulting geologist of Midland, Texas, spoke on "Paleogeologic Studies of the Permian," before the Tulsa Geological Society, March 2.



By Courtesy of the Denver Convention and Visitors Bureau

Colorado Museum of Natural History in Denver City Park. The twenty-seventh annual meeting of the A.A.P.G. will be held in Denver, April 22–24, 1942. The Cosmopolitan Hotel is headquarters.

GEORGE C. BRANNER, State geologist of Arkansas for the past 19 years, has been called to active duty as lieutenant colonel in the Quartermaster Corps, U. S. Army. RICHARD J. ANDERSON, assistant State geologist, has been appointed acting State geologist during the absence of Mr. Branner.

The Illinois Geological Society met in Mattoon, Illinois, in January and elected the following officers: president, CARL B. ANDERSON, Gulf Refining Company, Mattoon; vice-president, DARSIE A. GREEN, Pure Oil Company, Olney; secretary-treasurer, V. C. SCOTT, The Texas Company, Mattoon. KENDALL E. BORN, State Division of Geology, Nashville, Tennessee, presented a paper, "The Pre-Cretaceous Rocks of the Mississippi Embayment Area of Western Tennessee," before a joint meeting of the Illinois Geological Society and the St. Louis Chapter of the A.I.M.E., at the Pittinger Hotel, Centralia, Illinois, on the night of February 21, 1942.

JOINT ANNUAL CONVENTION, DENVER, APRIL 22–24, 1942

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS
SOCIETY OF EXPLORATION GEOPHYSICISTS

EDGAR W. OWEN[1]
San Antonio, Texas

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[1] Chairman, executive committee, A.A.P.G.

ANNOUNCEMENT

The twenty-seventh annual meeting of the Association will be held in Denver, Colorado, April 22, 23, and 24, 1942. Headquarters will be at the Cosmopolitan Hotel. The sixteenth annual meeting of the Society of Economic Paleontologists and Mineralogists and the twelfth annual meeting of the Society of Exploration Geophysicists will be conducted jointly with that of the Association. The Rocky Mountain Association of Petroleum Geologists is serving as host for the meetings, but all arrangements are under the direction of the executive committees of the three national organizations.

WAR-TIME READJUSTMENT

It is believed that the need for the meetings is greater than ever before and that a great deal can be accomplished by a thorough study of the conditions which the war has imposed upon us and by a concerted effort to adjust our scientific and technical resources to those requirements. The sacrifice of the time, energy, and expense entailed will be justified only by the accomplishment of constructive work which will increase the effectiveness of our participation in the war effort. Every convention activity will be directed to that end, and customary features which do not contribute to that purpose will be eliminated.

SPECIAL SPEAKERS

Every effort is being made to obtain participation in the program by nationally recognized authorities who can analyze the requirements to be made of the petroleum industry and appraise our resources for meeting them. Such addresses are planned to serve as the basis for a series of conferences on possible improvements in technique and employment of personnel.

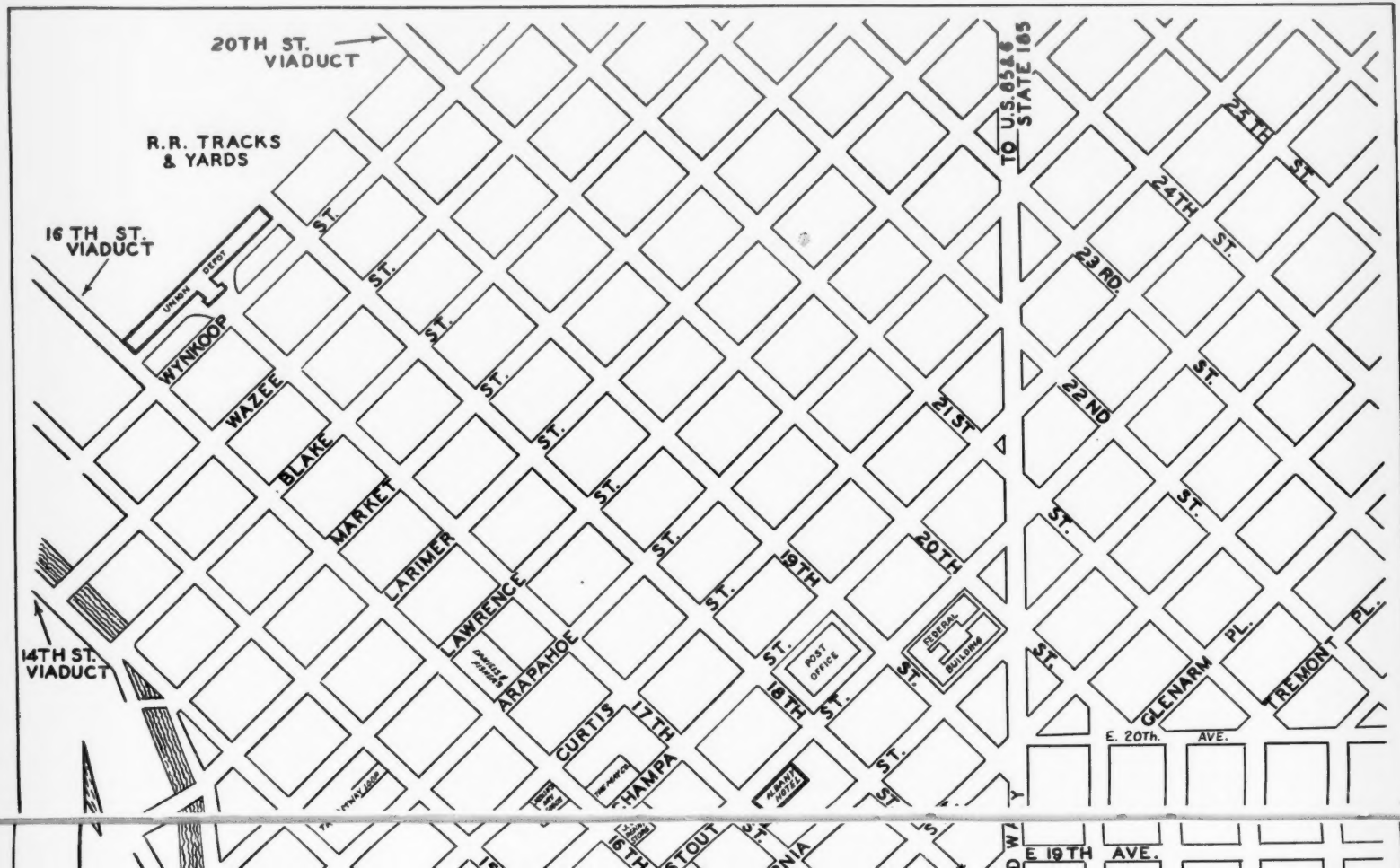
E. L. DeGolyer, director of the Conservation Division of the Office of the Petroleum Coordinator, and Wallace E. Pratt, director of the Standard Oil Company of New Jersey, are on the program.

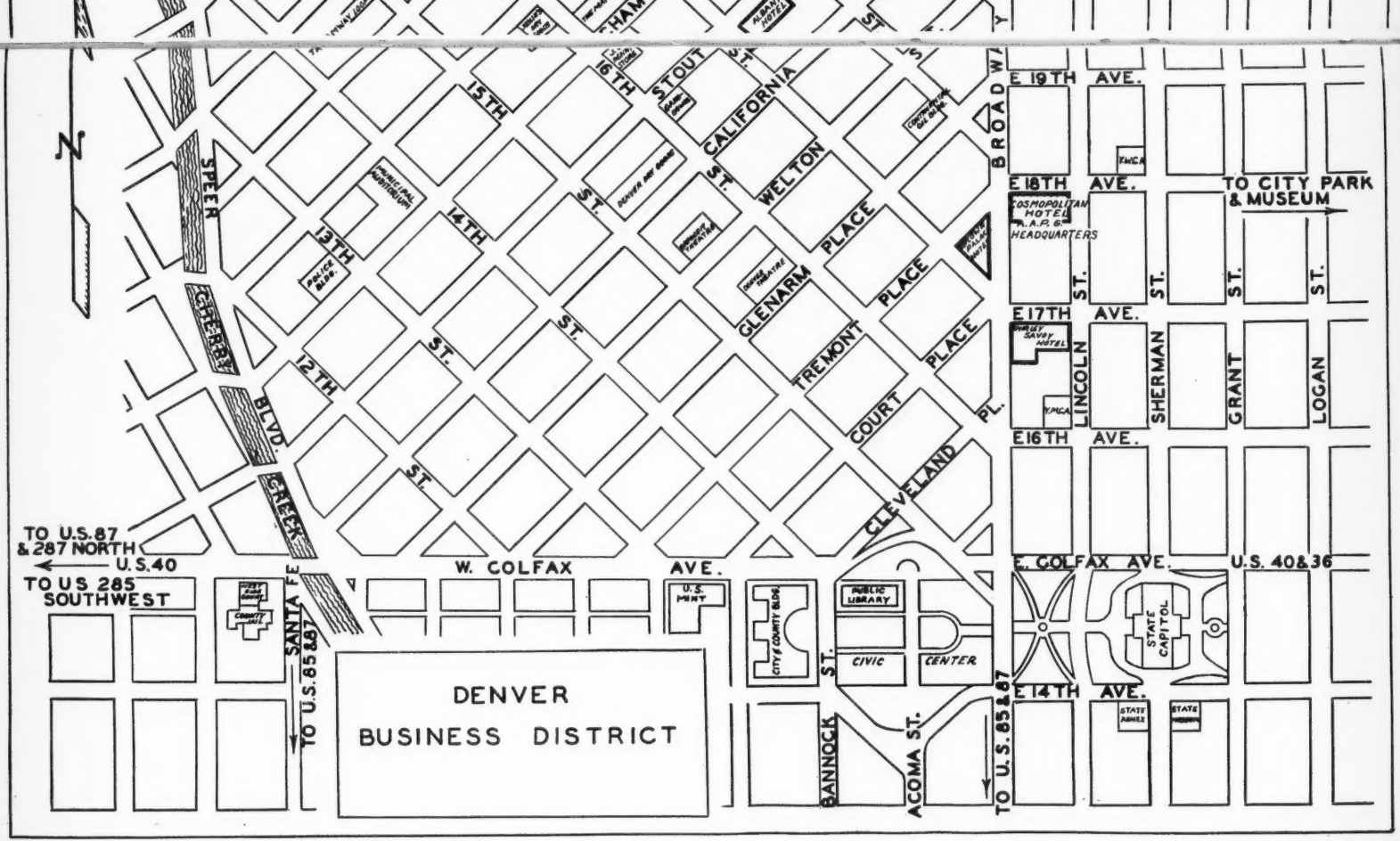
CONFERENCES ON WAR EFFORT

Special conferences have been arranged to consider various essential problems.

RESEARCH COMMITTEE SURVEY OF OIL-DISCOVERY METHODS. Tuesday evening, April 21, 8:00–11:00 P.M. This meeting will consist of a symposium of ideas and suggestions for maintaining an adequate oil-discovery rate in the United States. Oil discovery is the major concern of our profession and a cross section of its opinion should be of interest to all of our members and also provide a reserve of ideas which may be drawn upon by anyone interested in this problem. A. I. Levorsen is chairman of this committee.

JOINT CONFERENCE OF THE A.A.P.G., S.E.G., AND S.E.P.M. ON THE APPLICATION OF GEOLOGY AND GEOPHYSICS TO WAR AND POST-WAR PROBLEMS OF THE PETROLEUM INDUSTRY. Wednesday, April 22, 2:00–5:00 P.M. Under the co-chairmanship of a geologist and a geophysicist, an examination will be made of the emergency requirements for the various types of oil, distillate, and petroleum products, and how these requirements may be met most effectively in the several principal oil provinces by the application of geological


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and geophysical technique. This meeting will replace the usual technical program for the afternoon, and all members are expected to participate in the discussion.

It is planned to begin the conference with short special papers which will examine each of the principal oil provinces of the United States from the following angles:

(a) Are the present developed reserves of the province sufficient to supply all foreseeable demand from the area and to utilize all available pipe line capacity?
(b) Do certain classes of fields in the province furnish oil or gas of a kind which is especially essential to war time requirements?
(c) Does the province hold prospects for furnishing important amounts of new oil at a minimum expenditure of materials and labor?
(d) Is new exploration vitally important on account of the strategic location of the area with respect to transportation and refining facilities and security from attack?
(e) What applications of geological and geophysical technique can most efficiently meet the requirements indicated?

Alex W. McCoy and Paul Weaver are the conference chairmen.

CONFERENCE ON WAR-TIME PERSONNEL PROBLEMS. Wednesday, April 22, 8:00–10:00 P.M. A limited group, composed of the national service committee, the chief geologists and geophysicists of the large oil companies, or their delegates, and the district representatives of the A.A.P.G., will study emergency problems of personnel. The subjects to be considered may include:

(a) The proper scope of requests for selective service deferment
(b) The temporary employment of technical men to fill vacancies left by men going into military service
(c) Readjustment of personnel to meet emergency requirements
(d) Other similar problems which may be apparent at the time

William B. Heroy is chairman of this conference.

REGISTRATION

Members and guests should register immediately after obtaining hotel accommodations. The registration counter will be in the Lobby, first floor, of the Cosmopolitan Hotel, and it will be open from Monday noon until the conclusion of the convention. There will be no registration fee.

EXHIBITS

Scientific exhibits of timely interest will be displayed in the Blue Room and near-by corridors of the Cosmopolitan Hotel. Exhibits from State geological surveys and educational institutions are invited. Supervision of such exhibits will be undertaken co-operatively by members of the participating institutions who are present at the meeting, under the direction of the chairman for educational exhibits.

The annual exhibit of laboratory and field exploration methods and apparatus will occupy a large part of the Mezzanine Floor of the Cosmopolitan Hotel.

The entire display of up-to-date educational and technical equipment is expected to be specially significant and important this year.

PRE-CONVENTION SESSIONS

Attention is directed to the meetings of the business committee and various standing and special committees of the A.A.P.G., which are scheduled for Tuesday, April 21.

CONFERENCES, TUESDAY, APRIL 21, 2:00–5:00 P.M.

Origin of oil: Monroe G. Cheney and W. P. Rand, co-leaders
Migration and accumulation of oil: F. M. Van Tuyl and Ben H. Parker, co-leaders
Oil-field waters: L. C. Case, leader
Sedimentation: F. W. Rolshausen and W. C. Krumbein, co-leaders
Relation of oil analyses to stratigraphy: L. M. Neumann and N. W. Bass, co-leaders

The research committee conference groups which will meet on Tuesday afternoon are open to all interested members. Of outstanding interest is the general conference of the research committee on "Oil-Discovery Methods" to be held in the Ball Room of the Cosmopolitan Hotel on Tuesday evening. As usual, this meeting will be open to everyone in attendance at the convention.

FIELD TRIPS

Short field trips will be conducted to localities of outstanding geologic and scenic interest at the near-by Rocky Mountain Front on each day of the meeting. On Saturday and Sunday, April 25 and 26, a field trip will go by bus over Berthoud Pass to Glenwood Springs and Rifle, Colorado, returning to Denver via Loveland Pass. A very comprehensive view of Rocky Mountain structure, stratigraphy and scenery will be presented. California members taking the trip can resume their homeward journey from the western end with little loss of time. Plans for this trip are flexible, and final arrangements will depend largely upon the number of persons wishing to participate, and upon weather conditions. The estimated cost for the trip will be $12–$15 per person.

ENTERTAINMENT

Due to the unusual amount of work to be carried on during the convention, no special entertainment features are being planned. Denver affords plentiful facilities for entertainment during whatever leisure time may be available.

GOLF

The usual golf tournament will be omitted.

HOTELS

Make hotel and transportation reservations immediately. The Cosmopolitan Hotel may be fully reserved at this time, but it will refer your reservations to other hotels to accommodate you.

Hotel reservations should be made by each person directly with the hotel of his choice. Request the hotel for confirmation. The hotel committee, Charles S. Lavington, chairman, Continental Oil Company, Denver, will be glad to give advice about hotel accommodations.

COSMOPOLITAN HOTEL (Headquarters). All rooms with bath

Single	$ 3.30	$ 3.85	$ 4.40	$ 5.50
Double	5.50	6.60	7.70	8.80
Suites	10.00	12.00	15.00	18.00

BROWN PALACE HOTEL (Across street from headquarters). All rooms with bath

One person	$ 3.85	$ 4.40	$ 5.50	$ 6.60	
Two persons, double bed		5.50	6.60	7.70	
Two persons, twin beds	6.60	7.70	8.80	9.90	
Two room suites	10.00	12.00	14.00	15.00	$16.00

SHIRLEY-SAVOY HOTEL (One block from headquarters)

Single room with bath, on court, 1 or 2 persons		$ 2.50
Single room with bath, outside exposure, 1 or 2 persons		3.50
Room, twin beds, with bath—on court		3.50
Room, twin beds, with bath—outside exposure		4.50
Room with double bed, room with twin beds, connecting bath, for four—on court		6.00
Same with outside exposure	$7.00	8.00
Two-room suite with bath	8.00	10.00

Also special rates for several students in large rooms

ALBANY HOTEL (4½ blocks from headquarters). All rooms with bath and radio

Single	$3.00	$3.50	$4.00	and up
Double, twin beds	5.00	6.00	7.00	and up
Albany Annex				
Single	2.00	2.50	and up	
Double, twin beds	5.00		and up	

TRANSPORTATION

There is no special convention rate in effect on the railroads. You should see your local ticket agent about rates that may be available. Do this now.

TECHNICAL PROGRAM

On Wednesday morning, April 22, a joint session of the A.A.P.G., S.E.G., and S.E.P.M. will hear their three presidential addresses and special addresses on war requirements of the petroleum industry by authorities of national reputation.

The usual Wednesday afternoon technical session will be replaced by the conference on "The Application of Geology and Geophysics to War and Post-War Problems of the Petroleum Industry," as outlined in a previous paragraph.

The Thursday morning and afternoon technical sessions will also be joint meetings of the A.A.P.G., the S.E.G., and the S.E.P.M. Technical papers of general interest to the members of all three organizations will constitute these programs.

On Friday, April 24, technical sessions of the three societies will be held separately. The more specialized geological, geophysical, and paleontological papers will be presented at these morning and afternoon meetings.

The entire technical program will be directed as far as possible toward a contribution to the war effort. It will be necessary that many important papers, which have been solicited and which will be prepared, shall be read by title. Every effort will be made to arrange for the presentation of all papers which have a direct application to the war program or bear on fundamental research and development problems. All other papers which record the results of scientific work are solicited for publication in the official bulletins of the three societies.

The following papers have been submitted for the technical program of the A.A.P.G.

CONSTANTIN N. APSOURI—The So-Called Chert Nodules of the Oriskany Sandstone and the Problem of Phosphates.
NORVAL BALLARD—Notes on the Structural History and Oil Possibilities of the Dakota Basin.
A. F. BARRETT—Developments in the Rocky Mountain District in 1941.
R. L. BATES—Occurrence and Origin of Permian Evaporites.
O. L. BRACE—Developments in the Gulf Coast of Upper Texas and Louisiana in 1941.
KENNETH BRILL—The Late Paleozoic Stratigraphy of the Gore Area, Colorado.
L. S. CORYELL—Developments in North and North-Central Texas in 1941.
J. G. CRAWFORD—Oil-Field Waters of the Rocky Mountains.
PAT CROWLEY—Geology of Northwest Kansas.
C. E. DECKER—A Silurian Graptolite Horizon in Crane County, Texas.
C. E. ERDMANN—Applications of Geology in War.
P. P. GOUDKOFF—Foraminiferal Zones in the Upper Cretaceous of the Sacramento and San Joaquin Valleys, California.
R. P. GRANT—Developments in Michigan in 1941.
PAUL HARKER and W. C. IMBT—Viola Producing Zone, Reno and Stafford Counties, Kansas.
K. C. HEALD—Origin of Oil.
C. A. HEILAND—Applications of Geophysics in War.
L. G. HENBEST and C. B. READ—Pennsylvanian and Permian Stratigraphy of Northern New Mexico.
URBAN B. HUGHES—Developments in Southeast United States in 1941.
J. M. JEWETT and M. C. OAKES—Correlation of Upper Des Moines and Lower Missouri Rocks of Southeast Kansas and Northeast Oklahoma.
J. M. KIRBY—Upper Cretaceous Stratigraphy of the West Side of Sacramento Valley South of Willows, Glenn County, California.
R. C. LAFFERTY—Developments in the Appalachian District in 1941.
ROBERT C. LAFFERTY and RALPH N. THOMAS—Corniferous in Eastern Kentucky and Western West Virginia.
F. H. LAHEE—Discovery Rate and Relation of Wildcatting to Discovery of New Reserves.
W. B. LANG—Carlsbad Dolomite and Pisolites of the Guadalupe Mountains of New Mexico.
L. B. LEOPOLD—Climatic Character of the Interval Between the Jurassic and Cretaceous in New Mexico and Arizona.
WAYNE LOEL—Geology of a Portion of the Santa Clara Valley, California.
S. W. MULLER and H. G. SCHENCK—Standard of Cretaceous System.
L. L. NETTLETON—Geophysical Evidence on the Mechanics of Salt-Dome Formation.
F. A. NICKELL—Applications of Geology in Engineering.
W. T. NIGHTINGALE—The Fresh-Water Oil-Producing Wasatch Formation in the Rocky Mountains.
C. P. PARSONS—Caliper Logging in the Southwest.
E. S. PERRY and L. L. SLOSS—The Big Snowy Group of Montana.
T. C. PETERS—Stratigraphic and Correlative Relationships of the Geology of the Northern Mid-Continent-Rocky Mountain Area.
F. B. PLUMMER—Contributions of Petroleum Engineering Research to the Problem of the Migration and Accumulation of Oil.
F. B. PLUMMER and PAUL TAPP—Technique of Testing Large Cores of Oil Sand.
PAUL H. PRICE and A. J. W. HEADLEE—The Natural Coal Gas in West Virginia.
WILLARD D. PYE—The Physical Properties of the Bethel Sandstone of South-Central Illinois.
WILLARD D. PYE—Rapid Methods of Making Sedimentological Studies of Sands, Especially as Applied to Cores.
E. E. REHN—Onondaga Group of Parts of West Virginia and Virginia.
W. L. RUSSELL—The Interpretation of Neutron Logs.
CHARLES P. MILLER—Geological Factors which led to Discovery of Salt Lake Pool, Western Lea County, New Mexico.
JAMES L. TATUM and J. GARST—Plymouth Field, San Patricio County, Texas.



By Courtesy of the Denver Convention and Visitors Bureau

Explanation of cut on opposite page.

EUGENE L. EARL and FREDERICK W. MUELLER—The Sam Fordyce Field, Hidalgo and Starr Counties, Texas.
F. M. GETZENDANER—Problems of Pre-Trinity Deposits in South Texas.
PHIL MARTYN—The Greta Sands of South Texas. (By title.)
J. C. POOLE—The Coletto Creek Field, Victoria County, Texas. (By title.)
W. K. ESGEN—The Washburn Field, LaSalle County, Texas. (By title.)
LLOYD WEST—The Luby Field, Nueces County, Texas. (By title.)
DONALD J. MACNEIL—Stratigraphy and Structure of the Moose Mountain Area, Alberta, Canada.
GEORGE V. COHEE—Lateral Variation of the Chester Sandstones Producing Oil and Gas in the Lower Wabash River Area.
JED B. MAEBIUS—The Results of the Drilling of a Deep Test near Bay City, Michigan.
L. E. WORKMAN and TRACY GILLETTE—Subsurface Stratigraphy of the Kinderbrook-New Albany Strata in Illinois.
LOUISE BARTON FREEMAN—Silurian and Devonian Stratigraphy in the Area South and East of the Western Kentucky Coal Basin. (By title.)
R. M. ENGLISH and R. M. GROGAN—The Omaha Pool, Illinois.
ALFRED H. BELL—Development in Eastern Interior Basin, 1941.
W. T. NIGHTINGALE—Petroleum and Natural Gas in the Non-Marine Wasatch Formation of Northwest Colorado and Southwest Wyoming.

Titles of S.E.P.M. papers received are the following.

Part 1 (Friday morning)

1. W. H. TWENHOFEL—Rate of Deposition of Sediments.
2. W. C. KRUMBEIN—Physical and Chemical Changes in Sediments after Deposition.
3. GAYLE SCOTT—Development of Pyrite and Marcasite in Cretaceous Sediments of Texas.
4. E. C. DAPPLES—Changes in Sediments after Deposition Produced by Megaorganisms.
5. C. E. ZOBELL—Changes in Sediments after Deposition Produced by Microorganisms.

Part 2

1. C. E. NEEDHAM and R. L. BATES—Permian of Central and Northern New Mexico.
2. M. L. THOMPSON and C. E. NEEDHAM—Pennsylvanian-Permian Contact in New Mexico.
3. M. L. THOMPSON—The Stratigraphy and Fusillinid Faunas of the Marine Permian Wolfcamp in New Mexico.
4. F. B. PLUMMER—Stratigraphy of the Marble Falls Formation of Central Texas.
5. B. A. TATOR—Smaller Miocene Mollusca.
6. EDWARD MONSOUR—Fossil Corals of the Genus *Turbinolia* from the Gulf Coast.
7. L. R. WILSON—Vicksburg *Enoplostomellas*.
8. K. P. MCLAUGHLIN—Paleontology of the Fountain Formation of Colorado.

Part 3

1. H. G. SCHENCK and B. C. ADAMS—Operations of Commercial Micropaleontological Laboratories.
2. L. T. MARTIN—Eocene Foraminifera of the Type Lodo Formation, Fresno County, California.
3. STANLEY BECK—Eocene Foraminifera from the Cowlitz River, Lewis County, Washington.

Air view of Denver, Colorado, looking northwest. In the foreground is Denver's $11,000,000 Civic Center. The State Capitol is at the lower right, the City Hall at the left, forming the west side of the plaza. The large white building with the colonnade, at the upper right, is the Post Office, and the white building diagonally across the street, east of it, is the United States Customhouse, where the Geological Survey and other Government organizations are housed. The Union Depot is at the left top edge of the picture between viaducts crossing the South Platte River. The triangular building at the right of the center of the picture is the Brown Palace Hotel and east of it across Broadway is the Cosmopolitan Hotel, the headquarters of the A.A.P.G. twenty-seventh annual meeting, April 22–24, 1942. One block south of the Cosmopolitan is the Shirley-Savoy Hotel.

By Courtesy of the Denver Convention and Visitors Bureau

Explanation of cut on opposite page.

4. L. C. AYCOCK—Caddell Eocene *Operculinoides*.
5. R. HENDEE SMITH—New Species of *Discocyclina* from Alabama and Texas.
6. HANS E. THALMANN—The Genus Globotruncana and Its Species.
7. HANS E. THALMANN—The Genus Hantkenina and Its Subgenera.

Titles of S.E.G. papers received are the following.

L. E. DEACON—An Example of Reflected Refractions.
C. A. HEILAND—A Rapid Method for Measuring the Profile Component of Horizontal and Vertical Gravity Gradients.
MOTT-SMITH CORPORATION—Gravity expression of the Hatchetigbee Anticline.
L. L. NETTLETON—Calculation of Gravity and Magnetic Effects for Standard Forms.
E. E. ROSAIRE—Geochemical Survey of the Washburn Ranch Oil Field, Texas.
B. G. SWANN—Areal Distribution of Velocities in the Gulf Coast.
C. A. SWARTZ—Seismic Evidence Regarding the Depth of the Parent Salt Mass of Southern Mississippi.
DART WANTLAND—Magnetic Interpretations.

BIBLIOGRAPHY OF MILITARY GEOLOGY AND GEOGRAPHY

An 18-page pamphlet entitled *Bibliography of Military Geology and Geography* has been published recently by The Geological Society of America. This timely and useful information was prepared under the direction of W. H. BUCHER, chairman of the Division of Geology and Geography of the National Research Council. It is issued jointly by the Division and the G.S.A. The booklet is designed as a guide for the American geologists and geographers who wish to inform themselves concerning the ways in which their special training and experience may become useful in an armed conflict. This work is presented to the geologists of America by the Geological Society of America, and through the courtesy of that Society, free copies may be obtained postpaid at A.A.P.G. headquarters, Box 979, Tulsa, Oklahoma.

The Geological Society of America has also published the following pamphlets which may be obtained free by writing to Secretary H. R. Aldrich, 419 West 117th Street, New York City: *Utilization of Geology and Geologists in War Time* (10 pp.); *War; Geologists and Engineering* (7 pp.); by Sidney Paige.

PERSONNEL PLACEMENT OFFICERS

The 8th Corps Area of the United States Army, including Texas and adjoining states, has announced that PERSONNEL PLACEMENT OFFICERS will be located at the Army recruiting offices in the larger cities. Application should be made to these officers for information regarding branches of the service which require men with specialized education and experience. These officers can furnish blanks and questionnaires to men with special training who seek commissions direct from civilian life. Such applications when received will be forwarded to examining boards for use as needs may arise.

Men who are subject to draft, or wish to enter military service quickly, can enlist directly and then make application for transfer to officer training schools in the branches of service for which they are qualified. In most cases, this will probably be the quickest route to commissions.

It is understood that both the Army and Navy still need men with geophysical experience or electrical training qualifying them for sound detection work. Also, both services need additional men with meteorological experience. Any person interested should apply directly to Army personnel placement officers or Navy personnel procurement officers.

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Geologist
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Colorado Springs, Colo.
Main 7525
230 Park Ave.
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Consulting Geologist
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Meetings: Luncheon 1st Wednesday at Noon (12:00) and business meeting third Tuesday of each month at 7.00 P.M. at the Majestic Hotel. Visiting geologists are welcome.

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Meetings: First and third Wednesdays of each month, from October to May, inclusive, at 7:30 P.M., Edwards Hotel, Jackson, Mississippi. Visiting geologists welcome to all meetings.

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Meetings: Technical program each month, subject to call by Program Committee, Oklahoma City University, 24th Street and Blackwelder. Luncheons: Every Thursday at 12:00 Noon, Skirvin Hotel Coffee Shop.

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Meets the fourth Monday of each month at 8:00 P.M., at the Aldridge Hotel. Visiting geologists welcome.

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Meetings: Monthly and by call.
Luncheons: Every Monday at 12:00 noon, Blackstone Hotel.

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Meetings: Luncheon at noon, Worth Hotel, every Monday. Special meetings called by executive committee. Visiting geologists are welcome to all meetings.

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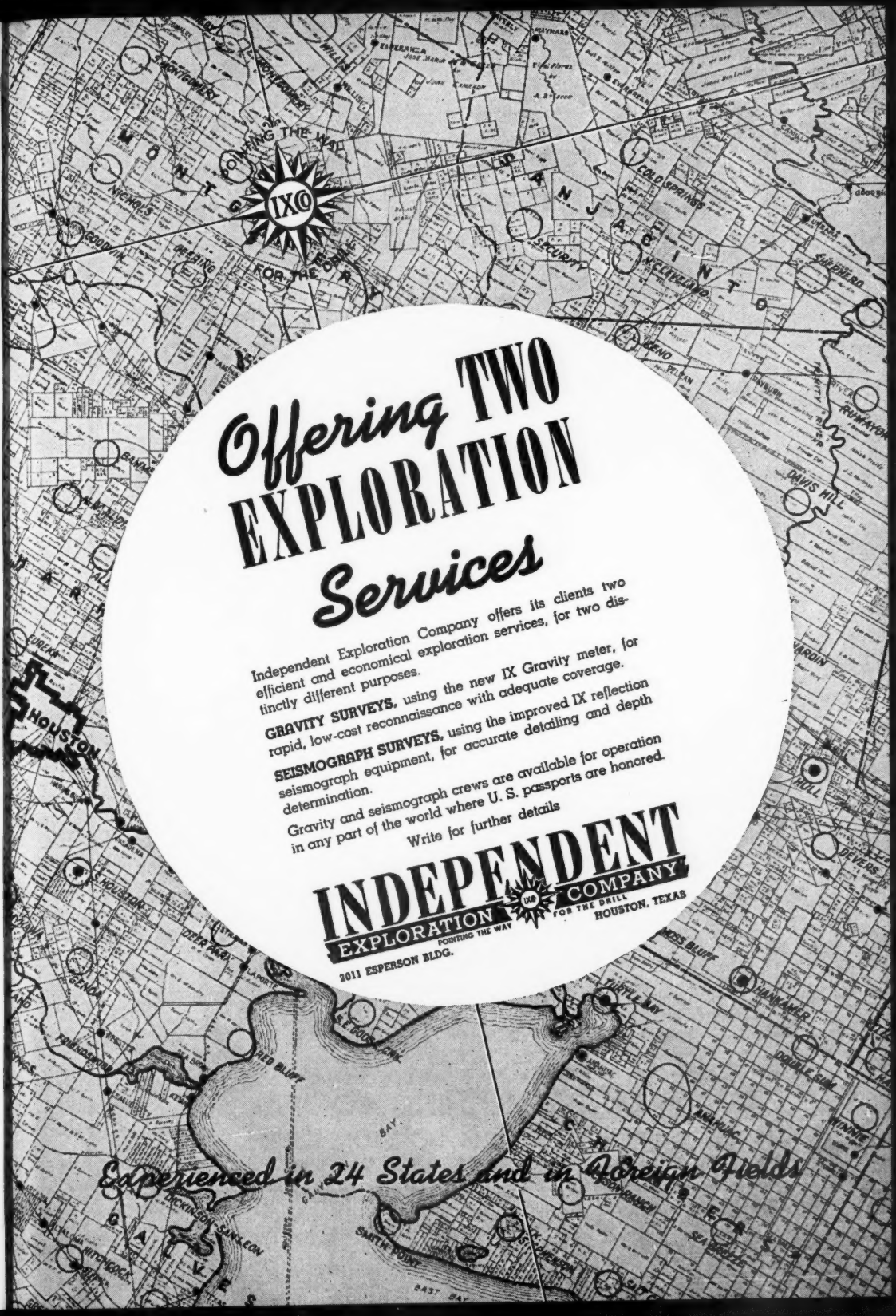
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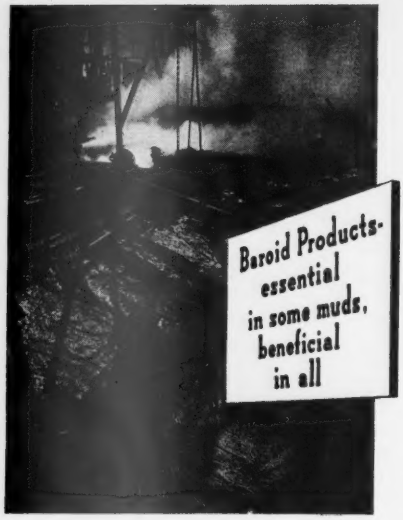

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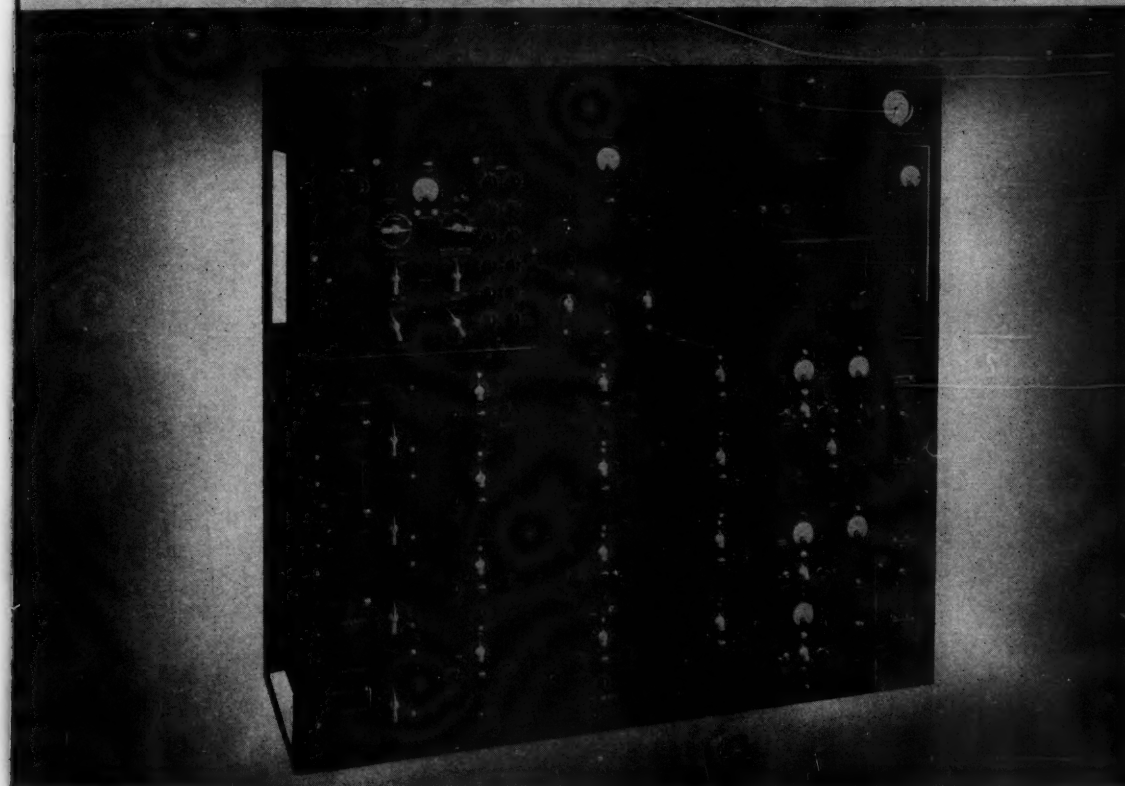
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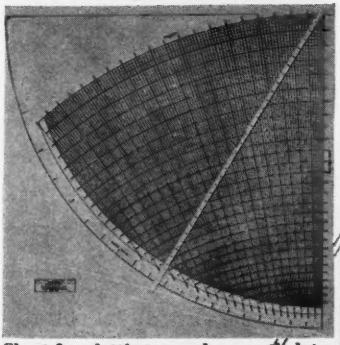


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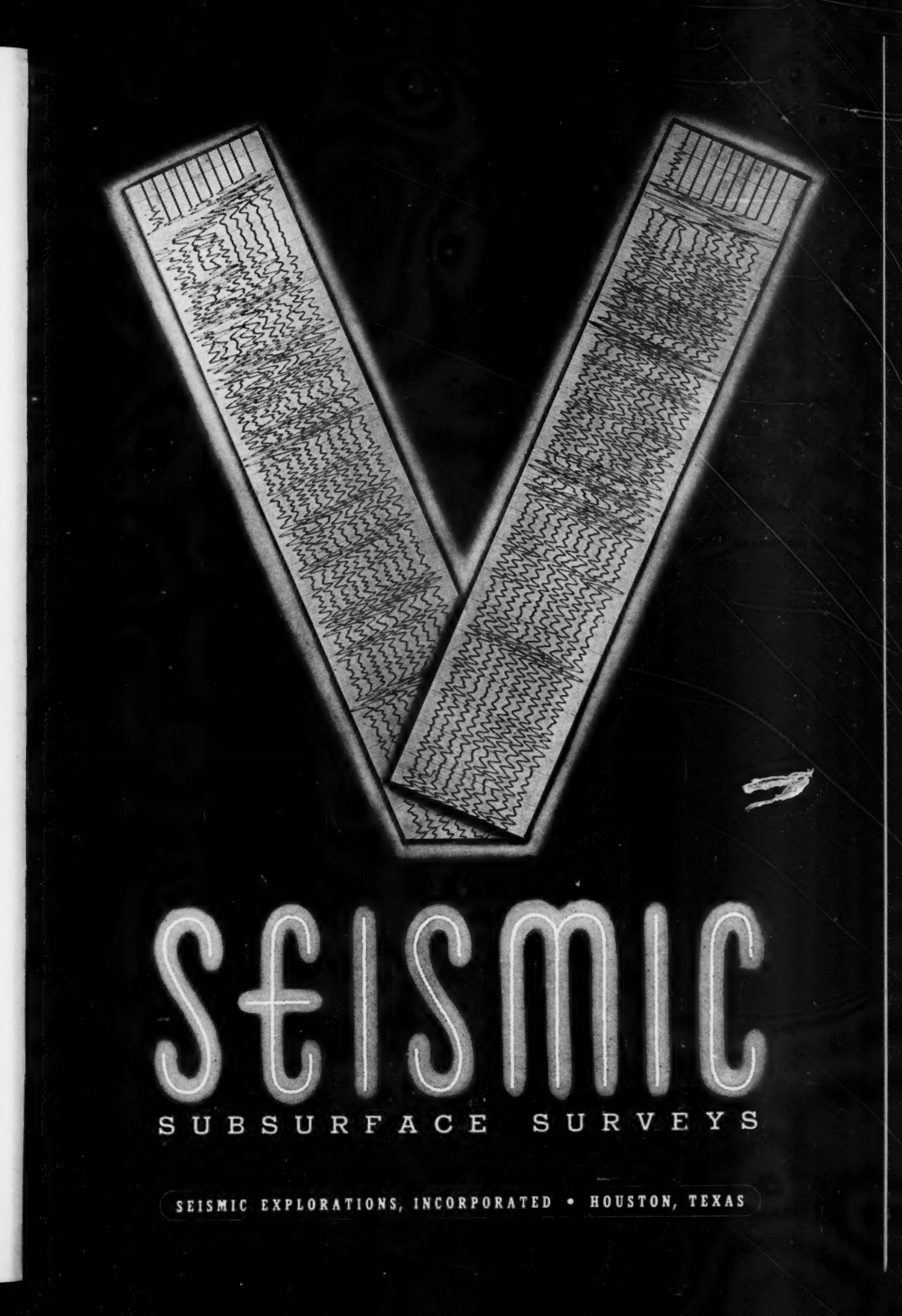
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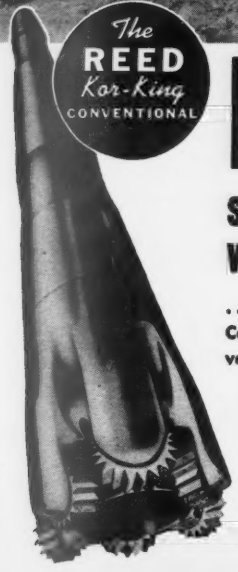
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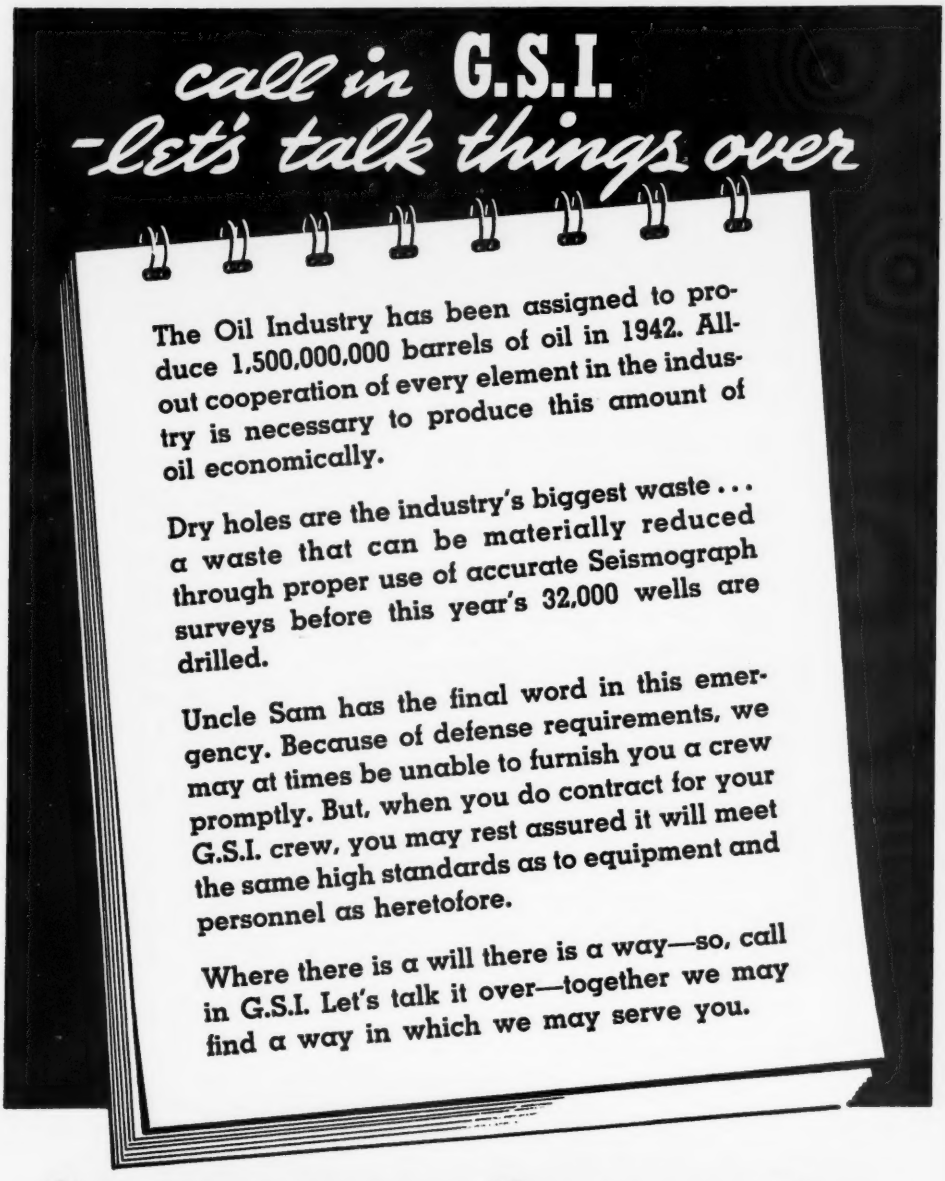




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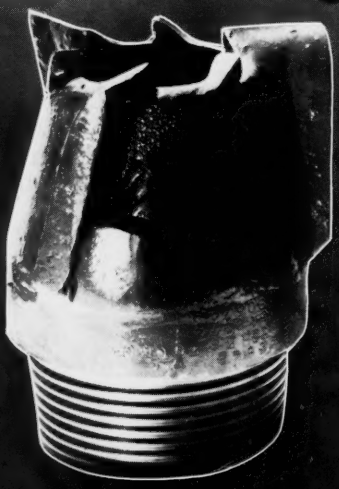
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